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THE EFFICACY OF GROUP DECISION SUPPORT SYSTEMS: A FIELD EXPERIMENT TO EVALUATE IMPACTS ON AIR FORCE DECISION MAKERS

THESIS

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THESIS

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Benjamin C. Huff

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Abstract

The current research contributed to the study of Group Decision Support Systems (GDSS) in field experiments which involve real managers making real world decisions. An independent research effort conducted by the Air Force Institute of Technology in cooperation with the Air Force Armstrong Laboratory evaluated the efficacy of using GDSS technology in an Air Force decision making environment. The study involved middle management Air Force civilian and military personnel who met in small five-member groups in a face-to-face setting. These groups participated in a choice-task decision making process over a two-day period. This study compared facilitated GDSS, facilitated manual, and traditional unfacilitated manual groups using a multi-methodological approach.

This study focused on performance and secondary outcomes resulting from GDSS effects versus process structure effects. The research evaluated two performance outcomes: the efficiency of GDSS in terms of decision speed and the effectiveness of GDSS in terms of consensus. Post-process questionnaires were used to compare groups with respect to eight secondary outcomes: user satisfaction with the decision making process and the group's results, and user perceptions of task difficulty, the group's ability to remain task-focused, the group's productivity in terms of time efficiency, the group's ability to reach consensus, the group's level of conflict, the level of process structure.

The study concluded that GDSS, process structure, and group dynamics impacted group performance. GDSS groups experienced slower decision speeds and lower levels of consensus when compared to facilitated manual groups which, in turn, experienced lower decision speeds and levels of consensus when compared to unfacilitated manual groups. The study showed that when all groups were considered, there were no significant differences between GDSS and facilitated manual groups, nor between facilitated manual and unfacilitated manual groups with respect to the secondary outcomes. However, when groups which received two experimental conditions were compared (i.e., cross-over groups), the study showed that participants perceived the tasks as being more difficult using GDSS than during the facilitated manual process. Likewise, participants perceived that the facilitated manual process was more difficult, more structured, and led to higher levels of conflict when compared to the unfacilitated manual process. These findings are consistent with other field studies which concluded that small groups or groups performing less complex choice-type tasks may not benefit from use of a GDSS.

THE EFFICACY OF GROUP DECISION SUPPORT SYSTEMS: A FIELD EXPERIMENT TO EVALUATE IMPACTS ON AIR FORCE DECISION MAKERS

I. Introduction

Over the past two decades, advances in small computer technologies, particularly Decision Support System technologies, have steadily provided a means of improving both the *efficiency* and *effectiveness* of **individual** managerial decision making. The use of small computers to facilitate **group** decision making is now being evaluated extensively in laboratory settings, but more importantly business settings. These computer systems are called **Group Decision Support Systems** (GDSSs).[1]

1.1 Background

Efraim Turban describes a GDSS as "an interactive, computer-based system that facilitates the solution of unstructured problems by a set of decision makers working together as a group" (38:132), (8:589).[2] Several major U.S. educational institutions, such as the University of Minnesota, the University of Arizona, and Indiana University have conducted a variety of GDSS-related experiments over the past decade. Allen Dennis and Brent Gallupe discuss the evolution of DSS and GDSS research into a new discipline within the Management Information Systems (MIS) field as summarized below (6:59–68):

- Phase I, Roots (1970s): Computer messaging and individual DSS studies.
- Phase II, Initial Explorations (Early 1980s): Rudimentary studies concerning the impacts of GDSS on group outcomes and processes.
- Phase III, Early Experiments (Mid-to-Late 1980s): Comparison of GDSS-supported versus non-GDSS-supported groups.
- Phase IV, Field Studies (Present): Research to examine impacts on organizations in a real world environment.
- Phase V, In-Depth Studies (Future): Examine a particular aspect of GDSS technology—a specific tool in a specific situation.

[1] Current literature includes GDSS under a broader category called GSS—Group Support Systems. These two terms are used interchangeably in this document to more accurately reflect information cited from the literature.
[2] Turban modified a DeSanctis and Gallupe definition in describing a GDSS.

Although the early research in Phases I and II was illuminating, the critical findings in GDSS have resulted from more recent studies. The focus of this research effort, therefore, was that of Phase III and beyond.

The laboratory studies of Phase III primarily chose undergraduate Business and MIS majors who had little job experience as participants. These studies usually involved a small group decision making task using either a Nominal Group Technique or Delphi group process. The researchers were mostly interested in evaluating a group's performance with respect to decision quality and decision speed, but also user satisfaction. As a whole, the results from many such laboratory studies were inconsistent.

Notwithstanding the overt differences in findings from the laboratory studies, some practitioners in the GDSS field have *catapulted* the technology into industry and are now (1991 to the present) reporting significant positive findings which result from the application of these systems in real world business situations. There are, however, few Phase IV GDSS field experiments and studies to validate or substantiate these positive findings. The lack of such data provides a unique opportunity to conduct valuable independent research applicable to Air Force activities.

1.2 Research Applicability to the USAF

The potential benefits of GDSS use in real organizational settings are just now being documented. As GDSS technology matures and gains widespread acceptance, Air Force personnel could conceivably use these systems to make group decisions in either single one-room settings or between numerous organizations geographically separated around the world. These computer-supported group sessions may better enable our senior leaders to make informed, yet complex decisions in a timely manner with improved coordination of USAF personnel. In addition to improved decision making, GDSSs may alleviate the need for extensive TDY travel, resulting in significant cost and time savings. The underlying problem is that there is no consensus in the Information Systems community that use of a GDSS improves group decision making. Likewise, there is little agreement that users will be satisfied with using this computer technology, nor accept it for widespread use in real business organizations. Because of the current uncertainties associated with employing GDSS resources, prospective users should carefully evaluate the potential for success by testing GDSS capabilities within their unique environments.

The Air Force's Human Resources Directorate of the USAF Armstrong Laboratory at Wright Patterson AFB, Ohio is currently establishing a GDSS research and evaluation facility where Air Force groups can assemble and obtain hands-on experience with GDSS technology. A primary

objective of the USAF GDSS program is to introduce the technology to many different organizations within the Air Force community and evaluate not only GDSS features and its ability to enhance decision making, but also to measure user perceptions and levels of acceptance. Should the results from these studies confirm the positive results proclaimed by commercial proponents, one future outcome of the Air Force GDSS research effort may be to operationalize this capability by infusing GDSS into the workplace, where deemed appropriate. By doing so, the Air Force could potentially benefit from improved decision making which, in turn, could improve organizational productivity in terms of reduced cost and time to conduct group decision processes. Although conventional meetings will continue to be one method for a group decision making process, GDSS technology may prove to be an attractive alternative for some situations.

1.3 Problem Statement and Purpose of Research

Currently, there is limited opportunity for GDSS researchers, in academia and industry, to examine *real world problems* in a group decision making environment while simultaneously applying appropriate measures of *experimental control.* This limitation hinders one's ability to observe truly significant results in the GDSS evaluation process. As discussed previously, there also exists a significant difference in results stemming from laboratory experiments (circa 1980–1991) and those of the more recent field studies (1991–1992). Although several researchers associated with the original studies have proposed explanations for the inconsistent results, others have called for additional research to reconcile the differences. For example, Ilze Zigurs in "Methodological and Measurement Issues in Group Support Systems Research" states that "what we still lack, however, [are] **field experiments that provide semi-controlled circumstances** [emphasis added] so we can tell just what is going on in these sites" (44:122). Zigurs' proposal to bring control or experimental structure to a real world group decision making environment is precisely the approach sought in this research.

The purpose of this study was evaluate the efficacy of GDSS in an Air Force decision making environment. The researcher conducted GDSS experimentation in an operational Air Force situation with sufficient experimental control to observe statistically meaningful results. Specifically, the research sought to objectively evaluate the effectiveness and efficiency of GDSS-supported groups compared to non-GDSS-supported groups in a *choice* decision making process. The research also attempted to compare results stemming from the application of GDSS computer technology to the application of process structure. Finally, the research sought to gain an understanding of the user's

satisfaction with, and acceptance of, GDSS technology as it relates to the group decision making process and its outcomes.

1.4 Research Objectives

There are several research objectives which support the purpose of this study. First, the research sought to measure GDSS and process structure effects as they related to performance outcomes of the group process: 1) group decision making efficiency in terms of decision making speed and 2) group decision making effectiveness in terms of consensus reached. Second, the research sought to measure GDSS and process structure effects in relation to secondary outcomes of the group process: 1) user satisfaction with the group process and group results; and 2) user perception of task complexity, group conflict, ability to remain focused on the task, productivity in terms of time efficiency and level of consensus, and amount of process structure. These objectives parallel those of the laboratory and field studies examined in the GDSS literature. To readily examine these objectives, they were further delineated into the following sub-objectives:

1. GDSS Effects: Performance Outcomes
   (a) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to decision speed.
   (b) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to consensus.
2. GDSS Effects: Secondary Outcomes
   (a) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's satisfaction with the decision making process.
   (b) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's satisfaction with the results of the decision making process.
   (c) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of task difficulty.
   (d) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of the group's ability to stay task-focused.
   (e) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of productivity in terms of time efficiency.
   (f) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of productivity in terms of ability to reach consensus.
   (g) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of the group's level of conflict.
   (h) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of the level of process structure.
3. Structure Effects: Performance Outcomes

(a) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to decision speed.

(b) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to consensus.

4. Structure Effects: Secondary Outcomes

(a) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's satisfaction with the decision making process.

(b) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's satisfaction with the results of the decision making process.

(c) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of task difficulty.

(d) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of the group's ability to stay task-focused.

(e) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of productivity in terms of time efficiency.

(f) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of productivity in terms of ability to reach consensus.

(g) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of the group's level of conflict.

(h) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of the level of process structure.

1.5 General Approach

The Air Force Institute of Technology (AFIT) and the USAF School of Aerospace Medicine conducted a conference at Wright-Patterson AFB, Ohio to identify critical education requirements for non-environmental professions for the USAF Environmental Education Master Plan. The participants of this conference met in small group settings and mapped applicable training ievels for 51 different environmental tasks to each of approximately 30 USAF professions.[3] Each member of the small groups voted individually. The groups conducted a *choice*-type decision making process in attempt to reach consensus using a five point scale for the appropriate training levels. For experimental purposes, participants were exposed to one or two treatments in the decision making process: facilitated GDSS, facilitated manual, and unfacilitated manual. Facilitators observed and recorded time and consensus data in order to compare decision speed and consensus levels between experimental conditions. Post-process questionnaires were administered to collect subjective user perceptions and levels of satisfaction. The data was analyzed for statistical significance in support of the sub-objectives identified previously.

[3]The terms "professions" and "career fields" are used interchangeably in this document.

1.6 Scope and Limitations

This research was limited to evaluating the performance of small groups consisting of five participants. These groups met in a face-to-face environment and performed a choice-type decision making process. Real-world conditions constrained the experimental design and the actual conduct of the research. Further explanation of these limitations is provided in Chapter III, *Methodology*.

1.7 Sequence of Presentation

Chapter II provides an overview of previous GDSS research with particular attention to theoretical principles, dependent variables of interest, and findings of experiments which compared GDSS with manual (non-GDSS) processes. Chapter III continues the discussion of the theoretical foundation with the methodology for the current research. Specifically, this chapter describes the equipment, facilities, people, and procedures used to successfully accomplish this field study. This chapter also provides an overview of the statistical tools applied in the analysis process. Chapter IV provides the results of the research, and finally Chapter V presents conclusions and any recommendations.

II. Literature Review

2.1 Introduction

The occasions when business managers or military leaders make "corporate-level" decisions *alone* are rapidly becoming quite rare. Chief executive officers and military commanders alike surround themselves with very capable and intelligent people who *together* make many of the critical decisions that lead to the betterment of their overall organization. Over the past two decades, computer technology has steadily provided a means to improve the efficiency of decision making by providing decision makers with methods for quickly consolidating and analyzing information (e.g., using database and spreadsheet programs). Likewise, computer support has led to increased effectiveness in managerial decision making: improved quality of the decision making process, better decisions, and more positive impacts on the organization (e.g., accurate forecasts of future corporate growth using operations research models). Historically, computers have been used at the individual decision making level. Today, the potential use of computers to facilitate *group* decision making—now being studied in academia and applied in industry—is furthering the state-of-the-art in information technology.

The purpose of this literature review is to acquaint the reader with several concepts and issues pertaining to Group Decision Support Systems (GDSSs) and provide an overview of the framework for GDSS research. GDSS is a relatively new concept. Researchers, educators, and writers began publishing GDSS-related articles in the early 1980s. Significant GDSS research efforts have been performed primarily at major universities, such as the University of Arizona, the University of Minnesota, Indiana University, and others. The results of these efforts, however, have been very mixed. This review attempts to highlight many topics concerning the study of GDSS technology which are pertinent to the current research, such as:

- Some activities and inherent obstacles associated with a group process.
- A general discussion of group decision support systems with respect to decision support systems.
- A framework for GDSS research (settings, components, functions, tasks, variables studied, et cetera).
- An overview of some preliminary results of both laboratory and field studies.

2.2 Group Decision Making Process

A brief explanation concerning the decision making process and the types of activities associated with this process is useful. Although a final decision is often made by a single individual—perhaps a top executive in a major corporation—decision making is usually a shared process with

members at various hierarchical levels within a particular organization. Such decisions often result from collaboration with, and cooperation between, members of a particular staff in a meeting where reaching consensus is important.

In a decision making process, the decision maker(s) must identify alternatives, examine all candidate proposals for acceptability and risk, evaluate each alternative in terms of a set of objectives or requirements, compare and rank the possible outcomes, and finally select the alternative which offers the best course of action (5:30–31). Gray describes these types of group meetings by the following characteristics (16:234):

- Meetings are a joint activity engaging 5 to 20 people all of equal or near-equal status.
- The activity and its outputs are intellectual in nature.
- Groups usually retrieve, generate, and share information in attempt to reach consensus or make a decision.
- The product of the meeting depends largely on the knowledge, opinions, and judgments of those attending.
- Differences in opinion are settled by decree of the ranking person or by negotiation of the participants.
- The results lead to subsequent action within the organization.

One benefit of group decision making is synergism—the whole being greater than the sum of its parts. Each participant brings a unique level of knowledge, understanding, and experience to a group. There is great potential for taking advantage of these attributes, but this potential may not be fully realized due to underlying destructive group dynamics, including 1) premature adjournment due to lack of critical information, 2)groupthink (pressure to conform to consistent thinking patterns of a highly cohesive group), 3) members not having the opportunity to speak or unwilling to confront issues, 4) suppression of participation due to monopolizing personalities, and 5) a lack of focus which wastes time (3:112). These obstacles certainly influence conventional group meetings, but some may be ameliorated by exploiting several reported advantages of GDSSs (3:112):

- **Groupthink.** GDSSs can provide anonymity of individual comments, allowing contradictory opinions to surface without fear of reprimand.
- **Competition for Opportunity to Speak.** GDSSs allow simultaneous contribution of ideas/comments.
- **Monopolizing Personalities.** GDSSs allow equitable participation, since all participants are allowed to "voice" opinions.
- **Environments Not Conducive to Confrontation.** GDSSs remove personal confrontation by using more nonverbal communication. Ideas, not people, become the focus of criticism.
- **Lack of Focus.** GDSSs enhance task focus through nonverbal communications and group visual provisions.

2.3 Delphi Process and Nominal Group Technique (23:73–74, 128)

Two popular group processes which have influenced GDSS software design and operational procedures are the Delphi process developed by the RAND Corporation and the Nominal Group Technique. These processes were developed in an attempt to improve the accuracy of group decision making (23:73).

The Delphi group process is primarily used in intellective problem solving tasks where a right decision, or one best solution, exists. Members work toward solving usually a quantitative problem, but they work alone. The anonymous decisions of fellow group members are provided to each of the individual decision makers. Throughout successive rounds of this decision making process, there is no direct interaction between group members. The process continues until the group reaches a result or consensus for a decision (23:74).

The Nominal Group Technique (NGT) is a two-stage group process used primarily for creative and planning types of decisions. In an initial stage, members work alone to individually generate ideas or identify alternatives for a particular problem. During the second stage, the members work together to evaluate alternatives to solve a particular problem. NGT is particularly useful for *choice* decisions (i.e., choosing) where voting mechanisms are employed. Individuals publicly cast an initial vote without prior discussion. This process is contrasted with the Delphi process, since here an initial vote is publicly cast, but is followed by interaction between group members. This discussion period allows individuals to explain their decisions before a group decision is made (23:74,128).

2.4 Discussion of Group Decision Support Systems

Before fully comprehending the concept of GDSS, one should become acquainted with *Decision Support Systems.* This section provides information highlighting the relationship of GDSS with its predecessor Decision Support Systems, and it identifies several goals and objectives for GDSS technology.

2.4.1 GDSS Relationship to Decision Support Systems (DSSs). Davis states that "the term DSS generally applies to [computer] systems that are designed to help managers evaluate and analyze complex situations" (5:xv). Experts in the DSS community qualify this characterization by generally defining a DSS as a computer system designed with hardware and software capabilities which provide real-time (i.e., immediate) analytical support to assist humans in making effective decisions. The distinguishing feature that sets a DSS apart from other computer systems is its

ability to provide real-time "what-if"-type analysis for a user (5:13). It is important to note that a DSS does not replace the decision maker—he or she still makes the final decision (5:47).

Since a GDSS includes components of a DSS (i.e., a data base, report generator, user interface, et cetera), a GDSS could be considered a DSS if only one person used the system. This situation, of course, is not intended. According to Gray, the requirements for a GDSS exceed those of a typical DSS by the following considerations (16:237):

- Expanded connectivity with a communications network to link several computers together.
- Enhanced software to provide voting, ranking, and other group decision tools.
- Improved availability providing additional operational uptime.
- Increased setup time before operational use.
- Expanded conference facilities with elegant furnishings.

2.4.2 GDSS Goals and Objectives. GDSSs, as previously stated, support more than a single decision maker and are considered a subfield of, or perhaps an evolution in, DSS technology. GDSSs offer the potential for improved facilitation of communications and decision support in a group decision making process. Gray discusses one motivation for using GDSSs—access to automated data retrieval, manipulation, and presentation in a meeting environment. Businesses have become highly dependent on computer support in the work place; however, when meetings are convened, managers and decision makers leave all the computer support behind. These computers provide essential access to corporate data and applicable software models upon which decisions are frequently made. In the conference room, quite often the only available information technology is the telephone and the overhead projector (16:234).

Making better group decisions is certainly an important goal for GDSS to succeed. Group participants, however, must also be satisfied with the process and the results produced before they will be willing to use these capabilities extensively over the long term. GDSS experts do not agree that these goals can be simultaneously achieved (8:606).

DeSanctis and Gallupe have provided a good foundation for GDSS research. They have stated that the aim of GDSSs is to "improve the process of group decision making by removing common communication barriers, providing techniques for structuring decision analysis, and systematically directing the pattern, timing, or content of discussion" (8:589). They also said that the objective of GDSSs is to "discover and present groups with new possibilities and approaches for making decisions" (8:595).

2.5 Framework of the GDSS Research Model

GDSS research has taken many forms; however, there is a semblance of structure within the literature which is briefly discussed in this document. Specifically, this section is devoted to addressing characteristics of the GDSS research in terms of group settings, GDSS components and levels of features, group activities/functions, decision making tasks, and the variables most often measured for effectiveness.

2.5.1 GDSS Taxonomy of Group Settings. Researchers are evaluating the application of GDSS primarily in face-to-face meetings; however, geographically separated (distributed) meetings have also been considered, but to a far lesser degree. The GDSS configuration varies with each meeting situation. Several scenarios are possible, depending on the duration of the decision making session (i.e., a temporal function) and the physical distance (i.e., a proximity function) between group members. Although neither wholly exhaustive nor mutually exclusive, the following general configurations are possible (38:134), (8:599–600):

Decision Room. All participants meet in one room for a fixed period of time. Each participant has a computer terminal to perform individual work and to transmit information to a common large screen display for public viewing. This room is also called a war room or face-to-face conference.

Legislative Session. Same configuration as the decision room, except that the number of participants has increased and inputs for public viewing must go through a *facilitator* (someone who controls the GDSS software and common display devices) prior to being displayed on the large viewing screen.

Local Area Decision Network. Individuals participate from terminals in their own work areas. Meeting members could be dispersed throughout a building or across town. This configuration does not require all participants to remain "on-line" at a given time (temporal function). An electronic facilitator can coordinate participant inputs in accordance with a prearranged schedule.

Teleconferencing. Participating individuals are geographically distant (proximity function) from one another; however, all are located in respective "local" decision rooms interconnected by audio, and perhaps video, communications capabilities. Conference participants meet at the same time. Teleconferencing simply supplements the existing GDSS capabilities.

Remote Decision Making. A large number of participants are widely dispersed and may participate in a conference similar to the local area decision network. This GDSS configuration allows either same time or different time use.

2.5.2 GDSS Components and Decision Room. Turban synthesized the typical GDSS architecture identified by DeSanctis et al into the following components (38:132):

1. Hardware.

   (a) Input/output device, preferably a microcomputer, for each participant to perform individual work or to send information forward to the group.

   (b) Common viewing screen to display information to the entire group.

2. Software (Group features in addition to individual work applications).

   (a) Numerical and graphical summarization of ideas and votes.

   (b) Programs for calculation of weights for decision alternatives, anonymous recording of ideas, formal selection of a group leader, and elimination of redundant inputs.

   (c) Text and data transmission capabilities among participants, between members and the facilitator, and between the group and central computer processors.

3. People.

   (a) Group members.

   (b) A facilitator or *chauffeur* who operates the GDSS hardware and software, and who displays requested information on the common large screen.

4. Procedures.

   (a) Rules on the operation of the GDSS hardware and software.

   (b) Rules concerning verbal communications among members and the flow of events during the meeting.

As noted above, GDSS components can be configured in a variety of ways within the GDSS taxonomy. The most commonly used configuration for research purposes has been the Decision Room. One of the first such facilities was the PlexCenter located at the University of Arizona. This facility actually has two decision rooms; the first and smaller facility was built in 1985, the second and larger facility was completed in 1987. Figure 2.1 shows a schematic of the first decision room. This facility is equipped with 16 networked microcomputers positioned around a U-shaped conference table. Information from an individual workstation or aggregated group data can be transmitted via a local area network to the facilitator's workstation and, subsequently, relayed to the large projector screen for public viewing. Several breakout rooms, complete with networked microcomputers, are available for side discussions. The second facility, shown in Figure 2.2, has 26 networked microcomputers and up to 60 people can use the room simultaneously. This room has two large display screens for dual projection along with greatly enhanced audio and video capabilities (42:19–20).

Integral to this facility is the GDSS software—originally the PLEXSYS Planning System.[1] The PLEXSYS Planning System is actually a knowledge-based software system, much like an expert system, with an inference mechanism which accesses both explicit and implicit knowledge bases (29:836). At some point in the 1980s, the University of Arizona, along with 12 other schools, was awarded a $2 million grant from International Business Machines, Inc (IBM) which was used

[1] The author assumes that the University of Arizona currently uses Ventana's *GroupSystems* software developed in cooperation with IBM as an evolution to PLEXSYS.

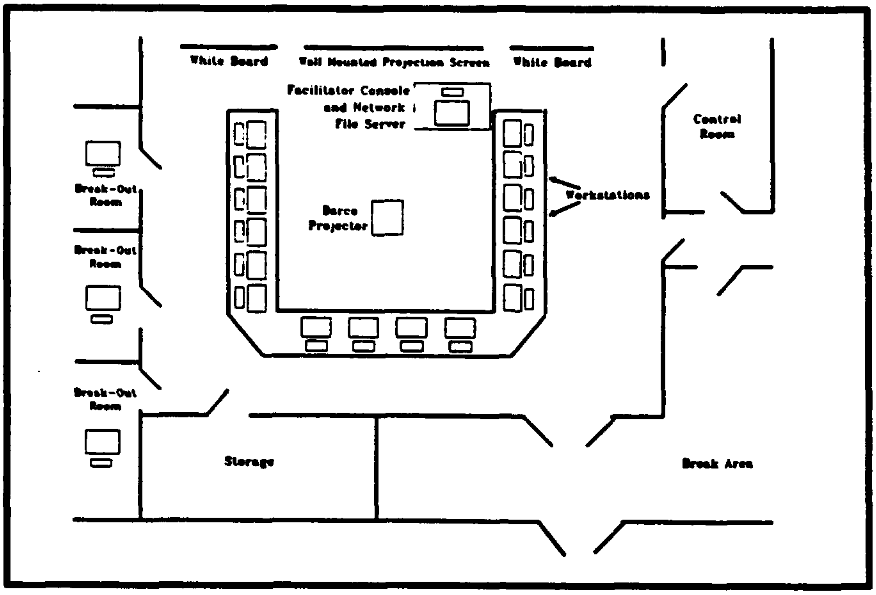

Figure 2.1. PLEXCENTER Decision Room #1 (42:20).

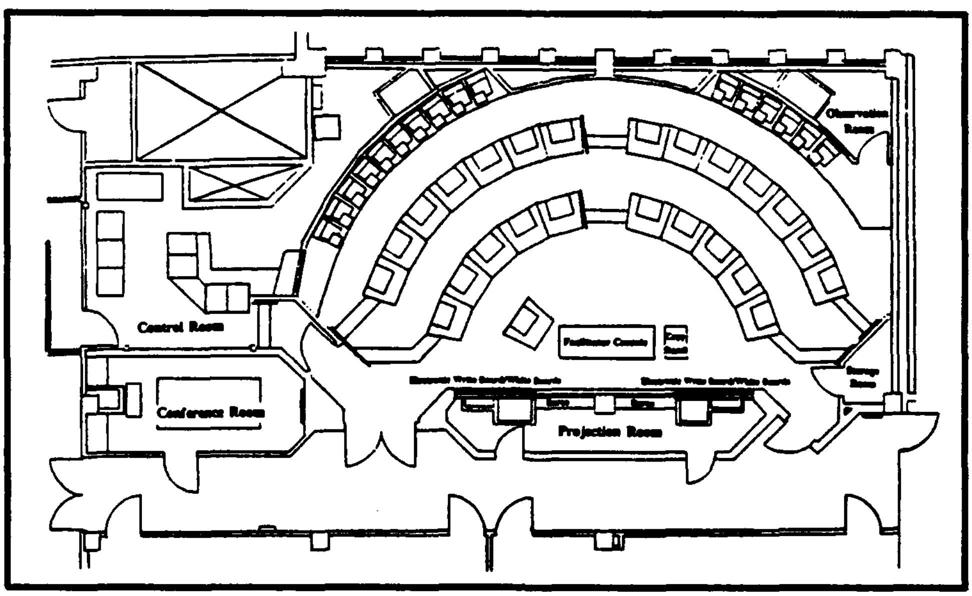

Figure 2.2. PLEXCENTER Decision Room #2 (42:21).

to expand existing GDSS hardware and software capabilities (30:185). This corporate-academic relationship matured, and today IBM and the University of Arizona together have built more than 20 GDSS facilities (called Decision Support Centers–DSCs) with approximately 30 additional facilities planned worldwide. The first IBM facility was built in 1987 at an IBM manufacturing plant in New York (30:185–186). Much of the field study data (700-plus GSS sessions) published by the University of Arizona and IBM have been collected at this facility. Although the specific details are not well-documented, Dr Jay Nunamaker, Head of the University of Arizona MIS department, has developed a new generation GDSS software package called *GroupSystems* which is marketed by Ventana Corporation. A similar GDSS package, developed in cooperation with IBM and called *TeamFocus*, is being used at IBM's DSCs.

In addition to GDSS hardware, software, and facilities, the role of the facilitator is critically important, and should not be underestimated. Although rarely included in most of the laboratory studies, the facilitator has an essential factor in the use of GDSS in field studies. The facilitator performs a variety of functions which include (31:134):

- Guiding the group through technical aspects of the GDSS process.
- Chairing meetings, setting agendas, and assessing the need to adjust meeting schedules.
- Taking necessary actions to improve group interaction.
- Assisting in planning meeting agendas with group leaders.

2.5.3 Activities or Functions Associated with GDSSs. Meeting activities using GDSS technology are similar to those of conventional meetings, except that more ***structure*** is added to the process along with a wealth of electronic assistance. Many GDSSs today include software tools for idea generation (i.e., electronic brainstorming), topic evaluation, ranking and voting, et cetera. These tools are designed to allow groups to address a relatively unstructured problem, derive alternative solutions, and ultimately make a final decision which they will later implement. Consider the primary software tools[2] offered by *GroupSystems*[3] (40:2-2, 2-4):

Electronic Brainstorming. An unstructured idea generation tool allowing participants to share ideas on a question or issue.

Idea Organization. A feature used to categorize comments and generate ideas, such as those created during brainstorming.

Topic Commenter. An idea generator which invokes a more detailed structure. Uses a predefined list of topics which participants comment on.

[2]This is a partial listing of the more popular software tools.
[3]These tools represent the next generation of the original PLEXSYS Planning System.

Alternative Evaluation. A method which allows participants to rate a list of alternatives against an established criterion.

Vote. The tool which allows participants to vote on a particular topic or issue. Results can be statistically analyzed and shown to the group.

Policy Formulation. A text editing tool which allows groups to iteratively comment on a proposed policy or mission statement until the group reaches consensus.

Group Matrix. A tool used to establish relationships between entities in a 2×2 matrix, either textually (from a predetermined list of words) or numerically. Cells within the matrix indicate the level of consensus.

Stakeholder Identification. A method to identify participants who either impact or are impacted by a proposed plan of action.

2.5.4 GDSS Typology of Tasks. In the early research, there was a need to standardize the classification of different group tasks to focus the experimentation effort. The study of group tasks is not new. In fact, such studies stem back to the late 1800s; consequently, the foundation for categorizing group tasks has already been laid. GDSS researchers have consistently applied the *typology* of tasks formulated by Joseph McGrath,[4] particularly in research conducted at the University of Minnesota and the University of Arizona (44:116). McGrath stated that "if we want to learn about groups as vehicles for performing tasks, we must either (a) assume that all tasks are alike...or (b) take into account differences in group performance as they arise from differences in tasks" (23:53).

McGrath's Group Task Circumplex (reference Figure 2.3) provides the needed framework to categorize and describe tasks associated with GDSS experiments and allows the comparison of similar studies. McGrath categorized group tasks into a *classification schema* which he stated should be "mutually exclusive (a task fits in one and only one category), collectively exhaustive (all tasks fit into a category), and logically related to one another" (23:60). The model is divided into four quadrants of activities or processes: Generate, Choose, Negotiate, and Execute; however, only the first three directly relate to GDSS group processes. Each of the Group Task Circumplex model's quadrants are subdivided into specific tasks—the level at which comparisons are easily made. These specific tasks are best understood in summary form and are shown in Figure 2.4.

Having a common model for the typology of tasks, researchers also needed to classify their experiments according to a taxonomy of GDSS group settings. Figure 2.5 shows two factors which captured the essence of this taxonomy: Group Size and Member Proximity. This taxonomy does not provide a third dimension for the temporal function (i.e., same or different times).[5] Combining the

[4]Based on the previous works of Shaw, Carter, Hackman, Steiner, Shiflett, Taylor, Lorge, Davis, and Laughlin (23:60).

[5]This void is probably due to the fact that the research appears to be limited temporally to "same time" settings.

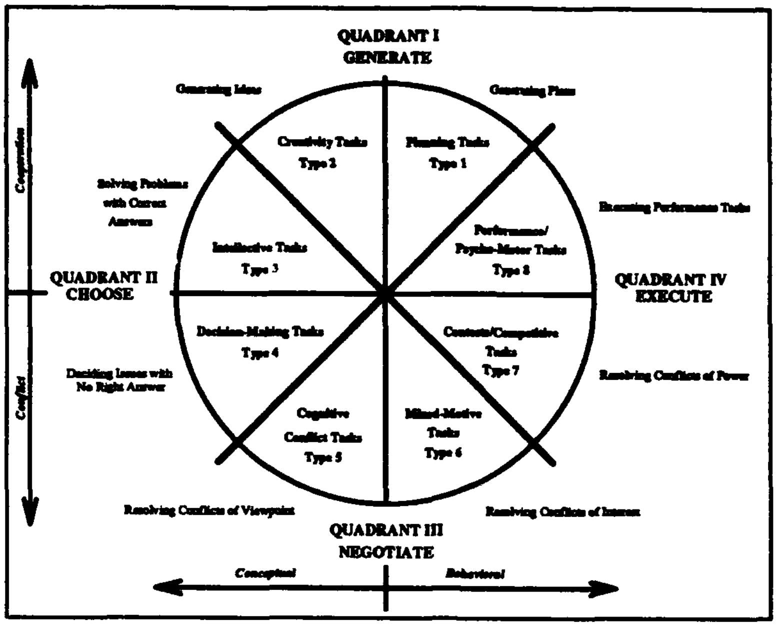

Figure 2.3. Group Task Circumplex—Typology of Tasks (23:61).

QUADRANT I: GENERATE

Type 1. Planning Tasks: generating plans.

Type 2. Creativity Tasks: generating ideas and brainstorming.

QUADRANT II: CHOOSE

Type 3. Intellective Tasks: solving problems with correct answers.

Type 4. Decision-Making Tasks: dealing with tasks for which the preferred or agreed upon answer is the correct one.

QUADRANT III: NEGOTIATE

Type 5. Cognitive Conflict: resolving conflicts of viewpoint, not interests.

Type 6. Mixed-Motive Tasks: resolving conflicts of motive-interest, namely negotiations and bargaining.

QUADRANT IV: EXECUTE

Type 7. Contests/Battles: resolving conflicts of power, competing for victory (e.g., wars, competitive sports).

Type 8. Performances: psychomotor tasks performed against objective or absolute standards of excellence (e.g., physical tasks, some sports).

Figure 2.4. Key Task Concepts for McGrath's Group Task Circumplex (23:62).

taxonomy of GDSS settings with the McGrath's Task Circumplex led to the contingency perspective for GDSS research recommended by DeSanctis and Gallupe (reference Figure 2.6). They referred to group size, proximity, and task type as "environmental contingencies critical to GDSS design" (8:589).

2.5.5 GDSSs Support to Decision Making Tasks. Already introduced, group dynamics can be obstacles which impede progress or paralyze communications among group participants. For example, one or two members may dominate the entire discussion. Timid or soft-spoken people may be unwilling to contribute their ideas to a discussion, especially if the issues are considered sensitive. On the contrary, some people have too much to offer, especially bosses who feel they must comment on every point brought up in a particular discussion (10:26). Other problems may include "extreme influence of high-status members and lack of acknowledgment of the ideas of low status members or the low tolerance of minority or controversial opinions" (8:596–597).

Destructive group dynamics hinder the effectiveness of group decision making. Because GDSSs allow simultaneous contribution of inputs by all members, destructive group dynamics should not be as significant. Another significant feature of a GDSS is the ability for individuals to anonymously make comments or suggestions. Nonverbally, they input information through their personal computer for all to view on a common display device (i.e., a large screen projection). This feature frees the individual from personal inhibitions to make open and honest comments about a particular subject. As Finley states, the system "forces attendees to tell the truth" (10:26). The group and the boss are forced to consider the merits of all inputs in an unbiased manner. In other words, all inputs receive equal consideration without regard to the status or credibility of the individual who thought of the idea. Johnson points out that anonymity may not be such a good idea, however. For instance, she states that anonymity "shields people who have not thought through their views carefully," and it can impede the verbal exchange that is necessary for clarification and feedback of new or confusing ideas (19:124). Generally speaking, the literature appears to support a positive position that anonymity potentially leads to improved decision quality.

Another GDSS attribute is the ability to keep meetings on track with participants focused on information provided visually on the large viewing screen. The desired end result is increased productivity and efficiency measured in terms of decision making speed. Decision making speed, however, can be controversial. Some experts feel that speed in reaching a particular decision is not as important a measure as the actual quality of the decision. In fact, by considering a larger number of alternatives to a problem—perhaps due to increased participation—decision time may actually increase, but the end product may be a much improved final decision. Essentially, the use

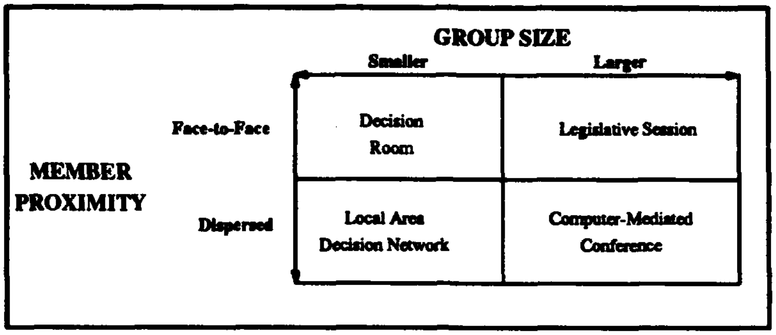

Figure 2.5. GDSS Taxonomy of Group Settings (8:598).

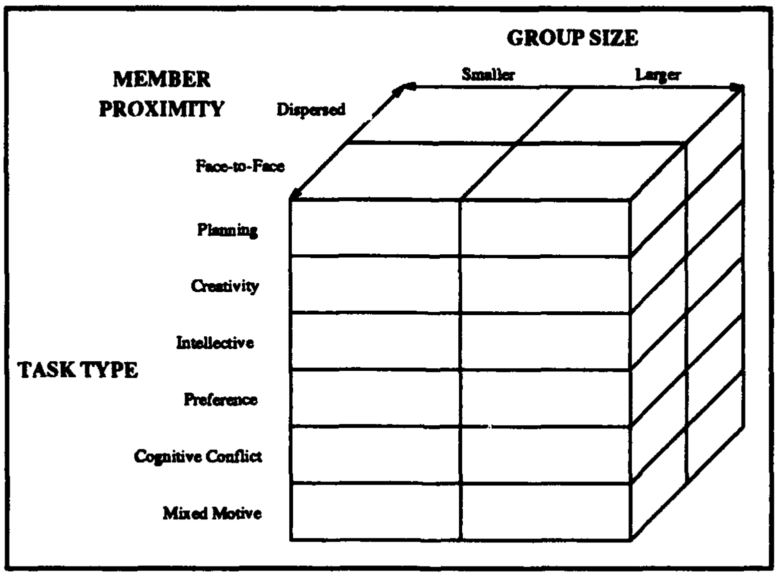

Figure 2.6. Contingency Perspective for GDSS Research (8:591).

Table 2.1. GDSS Features to Support Group Tasks (8:601).

TASK PURPOSE	TASK TYPE	GDSS LEVEL	POSSIBLE SUPPORT FEATURES
Generate	Planning	1	Large Screen Display, Graphical Aids
		2	Planning Tools (e.g.,PERT)
	Creativity	1	Anonymous Input of Ideas, Pooling & Display of Ideas
		2	Nominal Group Technique, Brainstorming
Choose	Intellective	1	Data Access & Display, Synthesis & Display of Rationales
		2	Aids to Finding Correct Choice, Forecasting Models, Multiattribute Utility Models
		3	Rule-Based Discussion
	Preference	1	Weighing & Ranking, Voting Schemes
		2	Social Judgment Models, Automated Delphi
		3	Rule-Based Discussion with Equal time to Present Opinion
Negotiate	Cognitive Conflict	1	Summary & Display of Opinions
		2	Social Judgment Analysis
		3	Automatic Mediation, Automate Robert's Rules
	Mixed Motive	1	Voting Solicitation & Summary
		2	Stakeholder Analysis
		3	Rule Base for Controlling Opinion Expression, Automate Parliamentary Procedure

of GDSS alters the nature of participation and the communication process of the group, hopefully resulting in better decision quality. The greater the impact to communication, the "greater the potential for an improved decision making process" (8:590 591).

2.5.6 Taxonomy of GDSS Levels. Based on McGrath's work, DeSanctis and Gallupe recommended possible GDSS features for three levels of GDSS sophistication. These features are shown in Table 3.1. To date, the research conducted and the commercially available GDSS software adhere primarily to Level 1 capabilities.

2.5.7 Group Decision Support Variables. There are numerous factors which influence any group process, many of which have been examined in the laboratory and field studies. Figure 2.7 shows the model Gray[6] proposed that contained the important categories of the different variables

[6]Gray summarized data taken from an unpublished working paper of DeSanctis and Gallupe entitled "Information System Support for Group Decision Making," University of Minnesota (undated).

affecting group decision making. These variables fall beneath three major areas: inputs, process, and outputs. Of these areas, the actual categories of variables are as follows (16:239):

1. **Inputs**: Group Factors, Individual Factors, Contextual Factors, and Technological Factors.
2. **Process**: Information Processes, Decision Techniques Employed, Group Dynamics Aspects.
3. **Outputs**: Performance and Secondary Outcomes.

Discussion of the applicable variables in an experiment is important when conducting GDSS research. One should identify which variables included in the study are controlled, measured, or not considered. This identification helps to precisely characterize the study so that others may conduct comparative analysis with similar experiments or replicate the study, if so desired. Gray points out that "the ability to replicate is important for validating existing theories." (16:239). One specific theory is that the use of GDSS improves performance outcomes, such as decision speed or decision quality. This leads to the discussion of measures of effectiveness.

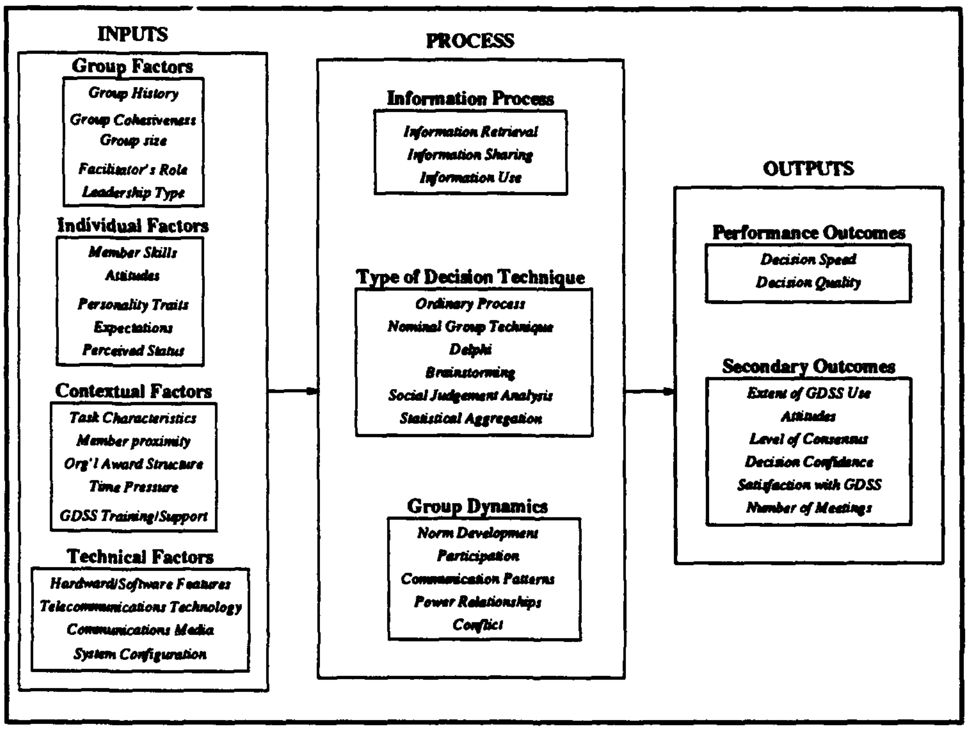

Figure 2.7. Group Decision Support Variables (16:239).

2.5.8 Measures of Effectiveness. In any experiment, results must be evaluated against criteria in order to measure the degree of success or failure. The results which are evaluated are the outcome variables proposed by Gray. These variables, identified as the ***dependent variables***, fall into two primary areas (16:239):

1. **Performance Outcomes.**
   (a) Decision Speed.
   (b) Decision Quality.
2. **Secondary Outcomes.**
   (a) Extent of GDSS Use.
   (b) Participant Attitudes.
   (c) Level of Consensus.
   (d) Decision Confidence.
   (e) Satisfaction with GDSS.
   (f) Number of Group Meetings to Reach a Decision.

Performance and secondary outcomes have historically been the focus for numerous experiments; however, three particular variables stand out as being the most often evaluated: decision quality, level of participation, and satisfaction with the process (7:600). These variables are derived from both the output and process categories. Zigurs noted that the *task-related* variables most often studied were decision speed, decision quality, consensus, and thoroughness of analysis. He also noted that the *satisfaction* variables most often studied were decision confidence, satisfaction with the process, and satisfaction with the decision (44:117). DeSanctis and Gallupe state that a dual purpose to facilitate high quality decisions and a high sense of user satisfaction using GDSS may be contradictory. They submit that researchers should be concerned with both aspects; however, improving the efficiency and effectiveness of group decision making are the more important criteria (8:606).

Explaining the output variables further, DeSanctis and Gallupe state that the "outcomes of decision meetings may be measured by the quality and timeliness of the decision, satisfaction with the decision, cost or ease of implementation, member commitment to implementation, and the group's willingness to work together in the future" (8:592). To date, GDSS laboratory and field studies comparing GDSS groups to manual groups, for instance, have not resulted in similar conclusions regarding these variables. In fact, the results have been overtly contradictory.

2.5.9 Conflicting Empirical Results. Researchers have drawn a number of contradictory conclusions concerning a GDSS's ability to improve the group decision making process. Comparison of the results taken from numerous laboratory studies, predominantly using undergraduate students as participants, has been largely inconclusive. In 1988 Dennis et al captured many of the

Table 2.2. Experimental Research: GDSS versus Non-GDSS (7:600).

STUDY	DECISION QUALITY	CONSENSUS	DECISION TIME	SATISFACTION WITH PROCESS	SATISFACTION WITH OUTCOME
Steeb & Johnson, 1981	Better		Increased	Increased	Increased
Lewis, 1982	Better			No Effect	
Ruble, 1984	No Effect				
Gallupe et al, 1988	Better		Increased	Decreased	Decreased
Beauclair, 1987	No Effect		No Effect		No Effect
Watson et al, 1988	Worse	No Effect		Decreased	
Zigurs, 1987	Better				
A. Easton, 1988	No Effect		No Effect	No Effect	Increased
G. Easton, 1988	No Effect	Less Likely	Faster in Face-to-Face	No Effect	
Jarvenpaa et al, 1988	Better			No Effect	

inconsistencies that existed (reference Table 2.2[7]) in those studies which compared groups using GDSS (decision rooms) to non-GDSS groups. The contradictions were obvious.

2.5.10 Accounting for the Differences. Dennis et al stated that the inconsistent results were derived from studies which used different GDSSs: different facility design philosophies, different software, and different measures of the dependent variables. They said that "there is so much variation across these studies that generalizations become problematic and cannot be made reliably" (7:602). In essence, Dennis et al claimed that the vast differences in the laboratory research methods made these experiments incomparable. Pinsonneault and Kraemer disagreed. In 1990, they separated the variables from these and other GDSS experiments into four broad categories for comparison: contextual, independent, intervening, and dependent. They made a distinction between Group Decision Support Systems and what they called Group Communication Support Systems (GCSSs) features. They concluded that there were favorable comparisons with relatively consistent findings (32:146–152).

Although not mutually exclusive, GDSSs contained experiments which primarily added structure to the group decision process (i.e., brainstorming, ranking, voting); whereas, GCSSs were experiments which merely provided information aids to support communications (i.e., electronic mail, teleconferencing, local area networks). Pinsonneault and Kraemer concluded that GDSSs had more positive impacts on group processes than did GCSSs as shown in Table 2.3 (32:143–159).

Two aspects of the previous discussion are very interesting. First, it is not totally clear how Pinsonneault and Kraemer assigned the experiments into the GDSS and GCSS classes once the variables were identified. Second, six of the ten "GDSS" experiments which they called comparable originated from the University of Arizona. It was here that Dennis et al had conducted research

[7]This table does not contain all the variables Dennis et al identified, but only those most pertinent to the current research effort.

Table 2.3. Comparison of GDSS to GCSS (32:151, 154).

	DECISION TIME	DECISION QUALITY	CONFIDENCE IN DECISION	GROUP SATISFACTION	CONSENSUS
GDSS	Negative	Positive	Positive	Positive	Positive
GCSS	Positive	Positive	Negative	?	?

and stated that most of the experiments were incomparable. Gray et al made several interesting observations as well.

Gray, Vogel, and Beauclair developed an alternate method for determining which experiments were similar and, therefore, could be appropriately compared. They dissected the Pinsonneault-Kraemer classification method[8] into a detailed level of 20 variables clustered into six *metavariables*. Some of these 20 variables were, subsequently, broken into *indicators* which could be scored with predetermined numerical values. Finally, weights were applied in order to differentiate the relative importance of each indicator (15:162–166). The example in Figure 2.8 illustrates the approach.

Once all the numerical assignments were completed, all experiments were evaluated to determine which had nearly equal values for all variables using Equation 2.1 (15:169). This equation provided the absolute difference between all experiments, evaluated pairwise. If the difference between a pair of experiments was five or less, they were deemed close (i.e., comparable). Gray et al plotted these experiments on a two-dimensional graph to illustrate similar experiments (15:168–170).

$$d(i,j) = \sum_{k=1}^{m} |v(k,i) - v(k,j)|/m, \tag{2.1}$$

where $v(k,i)$ and $v(k,j)$ represent the variable k in experiments i and j, respectively, and m is the number of variables used in the comparison.

Gray et al commented that "we have taken 11 of the 12 experiments that are considered here and also in Pinsonneault and Kraemer (1990)...[the results] show no clustering of experimental conditions within what Pinsonneault and Kraemer call GDSS studies...or those they call GCSS" (15:173–174). To make another counter argument, the researcher noted that half of the so-called "conflicting" experiments considered by Dennis et al to be incomparable appeared as being similar using Gray's analysis. This author concludes that there is no resolution for the conflicting results of the GDSS laboratory studies. Vogel and Nunamaker state:

[8]The Pinsonneault-Kraemer classification of variables is strikingly similar to that documented by Gray (1987) based on the unpublished work of DeSanctis and Gallupe—the true origin is certainly unclear.

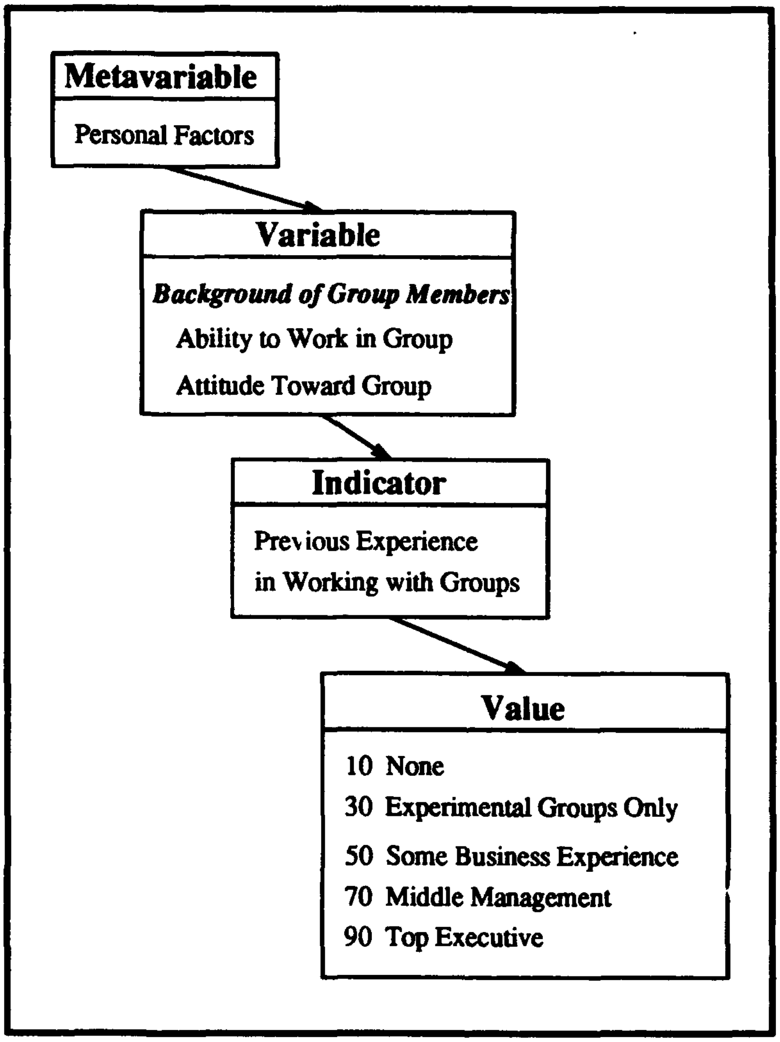

Figure 2.8. Metavariable Breakout (15:165–167).

...Many different results occur due, in part, to differences in technology, task, group size, leadership, and other potentially interacting variables. A caveat also exists in terms of degree of experimentation rigor, measurement sophistication, and accountability for confounding effects...we are still a long way, however, from understanding the implications of GDSS on group process and outcomes (42:19).

Dennis et al examined 24 variables on which the previous laboratory studies varied and concluded that the results were not contradictory—they were simply not comparable, since the studies themselves were not comparable (44:122). Zigurs responded to this statement by saying that "what we still lack, however, [are] field experiments that provide semicontrolled circumstances so we can tell just what is going on in these sites (44:122).

Rao et al state that these inconsistencies result from the researchers' failure to develop hypotheses and interpret results based on theoretical models. Research is moving forward without the reconciliation of these inconsistent findings. Rao states that researchers need to link GDSS support features to theoretical models such as communications, minority influence, and limitations of human information processing and computational abilities (33:1347–1351). Turban also notes the disparities which exist between laboratory experiments and field studies. He advocates that researchers embark on studies in both arenas and apply the conclusions drawn from experimentation to use of GDSSs in business organizations (38:140).

Vogel et al have conducted numerous studies within academia and business. They contend that GDSSs can be successful in meeting the goals of effectiveness, efficiency, and user satisfaction. They state, however, that "failure to capture and implement " the following items can "easily result in adverse effects" (41:126–127):

- Facilities must provide a professional setting using sophisticated software and hardware which are well-organized and effectively supported.
- There must be the ability to accommodate groups of sufficient size that may vary in composition and experience which address real and complex tasks.
- Facilitation must be technically competent and appreciate group dynamics as well as a research orientation that encompasses a multi-disciplinary approach.

2.5.11 Progress Made in Industry. There is a virtual void of GDSS field experiments and field studies, except those associated with Dr Jay Nunamaker, Head of the Department of Management Information Systems at the University of Arizona. Using Ventana Corporation's *GroupSystems*, his research has largely focused on the commercial sector, primarily International Business Machines, Inc (IBM). Nunamaker et al[9] proclaim overwhelming success in applying GDSS tech-

[9] Vogel, Dennis, and others are progeny of the University of Arizona GDSS/GSS research efforts—either as doctoral students or faculty.

nology in the field—directly contradicting the results of the earlier laboratory studies. Vogel et al summarize some of these results (42:24):

> The efficiency and effectiveness of these methods have proved to be overwhelmingly positive. Project calendar days have been reduced by orders of magnitude. The number of meetings have been reduced accordingly. Person-hours expended have been dramatically reduced, with an average savings of 55% based on experience with comparable unsupported groups. Comments have praised the fairness and comprehensiveness of the process and a desire to use the facility in the future. Satisfaction measures have been especially positive. Group members consistently felt that the computer-aided process is better than the manual one in terms of ideas generated, goal achievement, commitment generation, fairness, and efficiency. The facility has never been advertised, yet is now fully booked with groups based on word-of-mouth of successful use.

While GDSS researchers continue to grapple with the inconsistent results from the laboratory studies, businesses are beginning to realize actual productivity gains (i.e., real dollar savings) using GDSS. Commercially available GSS software packages, such as *OptionFinder*, *GroupSystems*, *TeamFocus*, *VisionQuest*, and others are currently being used in industry (28:3).[10] Kirkpatrick points out that the potential for GDSS paybacks is tremendous, considering the average manager spends almost half the work day in meetings. Kirkpatrick provides some fairly impressive results and substantial corporate commitments to using GDSS technologies (20:93–96):

- Boeing cut the time needed to complete a wide range of team projects by 91% and saved on average $6,700 per meeting due to reduced employee time.
- IBM reported project planning time reductions of 56%.
- J.P. Morgan, Price Waterhouse, Marriott, and other companies started using GDSS and/or have built a Decision Room for GDSS purposes.
- IBM is in the process of building 50 Decision Rooms worldwide which it plans to rent to other companies at $2,000 to $5,000 per day.

Business productivity gains have been significant. For example, Boeing, using the GDSS software package *TeamFocus*, cut the time to design a standardized control system for complex machine tools from one year to 35 days. Boeing reported that the time to complete a wide range of projects was cut by 91% (20:93). These results seem astounding, yet are difficult to objectively substantiate in the literature. For example, the IBM findings (56% reduction in project planning time) are very subjective. Nunamaker et al state that "actual man-hour data were aligned with **anticipated time estimates** [emphasis added] based on leader experience and historical precedents" (30:187). He provides the following amplification:

[10] *OptionFinder* is a registered trademark of Option Technology, Inc., *GroupSystems* is a registered trademark of Ventana, Inc., *TeamFocus* is a registered trademark of IBM, Inc., and *VisionQuest* is a registered trademark of Collaborative Technologies, Inc.

> The efficiency of the system as used in this study is an indication of the relative costs and benefits to the organization compared with doing the same function manually. It was not possible to run parallel sessions with control groups to measure efficiency directly. However, prior to use of the [Decision Support Center] facility and without knowledge of automated support capabilities, each group leader was required to recommend and document a feasible project schedule for the accomplishment of his or her group's objectives, based on previous experience with similar projects. These schedules defined the historical parameters for the projects and a baseline for comparison with the efficiency of the automated support...After completion of the project, expectations before use of the tools was compared with what actually occurred. Further, the output from the sessions was independently evaluated by a knowledgeable third party to gain a measure of what it would take to arrive at the same level of accomplishment using traditional manual processes...man-hours were saved in every case recorded, with an average per session savings of 55.51% (30:189).

It could easily be argued that these estimates are so highly speculative and subjective in nature that they probably can not be accepted at face value without credible, independent substantiation. On the other hand, regardless of the laboratory research findings, the previous *testimonies* are difficult to ignore. The appeal to what is being said about GDSS technology in industry is that these companies appear to have discovered that potential time and cost savings, as well as improved effective decision making, are realizable goals.

2.6 Areas Requiring Further Research

Except for a handful of field studies, primarily those of Nunamaker et al, GDSS laboratory studies to date have involved inexperienced undergraduate and graduate Business and MIS students resolving fictitious, unvalidated tasks (42:18), (12:279). Examples of the tasks performed during the experiments include (12:279):

- A foreign embassy takeover by a terrorist group (planning).
- Severe financial problems at a university (idea generation).
- A group of people must survive Arctic conditions (intellective).
- A student misconduct case at a university (policy formulation).
- A firm is losing profits at the same time sales are rising (problem finding).

The design of such research is severely constrained by the lack of experienced subjects, not the lack of a desire to study under more realistic conditions. Obviously, there exists a genuine need to conduct GDSS research in real business settings with real managers solving real problems. There is also a need to use similar GDSS software packages and similar environmental conditions (setting, task, et cetera) for a better comparison of results between studies. The following comments made by prominent GDSS researchers and authors affirm these positions:

- "Additional research is warranted to expand field observations and integrate aspects of field and experimental research in order to achieve a more comprehensive understanding of the implications for organizations..." (Nunamaker, Vogel, et al,1989), (30:195).
- "There is a real need for field studies in real organizational settings [with real managers]" (Pinsonneault and Kraemer, 1989), (32:158).
- "What we still lack, however, is field experiments that provide semi-controlled circumstances so we can tell just what is going on in these sites" (Zigurs, 1993), (44:122).
- "We are much more likely to get a true picture of overall GDSS impact over time through field studies than lab studies" (Lewis and Keleman, 1990), (21:204).
- "Additional research is warranted to expand field observations and integrate aspects of field and experimental research in order to...achieve a more comprehensive understanding of the implications for organizations of the adoption of Group Support Systems" (Nunamaker et al, 1989), (30:195).
- "Students were used as subjects because it was difficult to recruit executive groups to participate in a field experiment" (Jessup et al, 1991), (18:269).
- "The use of students may not have been a wise choice. GDSS technology is designed for use by persons who often make complex decisions in groups...and would have real-world experiences from which to make comparisons...The results suggest that GDSS is not very effective when introduced without a specific goal or target audience, nor does it appear necessarily useful or effective when used with groups that do not have a vested interest in the task...While using a more focused, real-world case...would limit the potential sample of subjects, these subjects would more accurately represent the population that would most likely use such a system in an organization" (Beauclair, 1989), (1:329, 331).

2.7 Summary of Existing Research

In the book *Group Support Systems: New Perspectives,*[11] Alan Dennis and Brent Gallupe recap the study of GDSS from its inception to the present. They conclude that the field studies have reached generally positive results, contrary to those of the earlier laboratory studies which were largely inconsistent. Specifically, they conclude that GSS groups during the field studies were largely satisfied with the process and outcomes, and that users perceived that the technology improved effectiveness and/or efficiency—contrary to the earlier laboratory findings (6:73). Dennis and Gallupe highlight a popular premise which partially explains the dichotomy of the findings: field studies involved larger groups, using managers or professionals performing complex tasks over several days, and included an active facilitator; whereas, laboratory studies usually involved students performing relatively easy tasks over an hour or so without the aid of a facilitator (6:68). Dennis and Gallupe offer the following additional conclusions (6:73):

- GSS use in the field appears to improve performance, efficiency, and user satisfaction.

[11] Compiled and edited by Leonard Jessup and Joseph Valacich.

- Effects of GSS depend not only upon aspects of the technology, but also upon factors pertaining to the specific group and task.
- The most important aspects of a GSS situation are group size, task complexity, and task type.
- Larger groups benefit more from GSS use than do small groups.
- GSS "better fits" complex tasks than simpler ones.

Finally, Dennis and Gallupe state that GSS use can "dramatically improve group performance and satisfaction for *generation tasks* [emphasis added] " but they are " less convinced that GSS technology can help groups facing a *choice task* [emphasis added] where the objective is to choose an alternative from a prespecified set. GSS may help, but the evidence is not as clear" (6:73).

2.8 Conclusion

The use of GDSS in any organization holds potentially great promise for improved group decision making. GDSS reportedly 1) enhances the participation of group members, 2) allows simultaneous communication of ideas, and 3) solicits the inputs of otherwise timid or quiet participants. The end result is the perception that GDSS improves decision making, and users are satisfied with the process and the results.

According to DeSanctis and Gallupe, the most difficult issue in GDSS research is finding the desired balance between decision quality and user satisfaction. Often, quality is sacrificed for user acceptance or vice-versa. Their position is that these two goals may be conflicting and, thus, "the long-term objective of GDSS technology should be to improve the efficiency and effectiveness of group decision making...member satisfaction with the process is necessary but not [a] sufficient condition for a successful GDSS" (8:606).

It may be too early to field these systems on a global scale until we understand the technology and the environments which will benefit from its implementation. Gray states the following (16:233–234):

> When these systems are installed in industry and government, they behave like shooting stars. They are put in by one senior executive and used during his or her tenure. However, as soon as that individual is replaced, the system is dismantled or falls into disuse. The major problem is that at this point we do not know how to use these systems effectively [or] how to train people (particularly middle-aged executives) how to use them...One possible outcome...is that GDSS may be a solution for which there is no known problem.

This relatively new and emerging technology is certainly not well-understood. There remain many opportunities for additional research. If large corporations, such as IBM and Boeing, are

realizing improved productivity and decision making, the Air Force could potentially benefit, too. We should, however, apply GDSSs where it makes the most sense, when the technology is mature, and when we understand how to use it. GDSS proponents have stressed the need to conduct field research within specific management environments. The Air Force should proceed in exploring GDSS technologies through research and development efforts now, because this is a rare opportunity for the military to not only capitalize on the advances being made in this unique information systems field, but also to influence future development of the technology.

III. Methodology

3.1 Introduction

Researchers have studied GDSS technology using a variety of approaches. In total, these studies have produced a variety of mixed or contradictory results. The importance of documenting the research approach and the experimental conditions is paramount, since much of the literature claims that results are very much situation-dependent. The purpose of this chapter is describe the real-world environment in which the current study was conducted and the methodology that was followed. Specifically, this chapter describes the real-world situation where GDSS technology was studied, explains the field experiment design that was developed for this environment, and discusses the statistical methods that were used to analyze the collected data.

The importance of the current study is best understood in light of the research discrepancies noted in Chapter II. This study places significant experimental control on a ***real organizational problem*** involving ***real Air Force managers*** in a ***real organizational setting*** in order to provide near-experimental conditions for more objective measurements, but with enough flexibility to allow the GDSS to be exploited for operational use. The setup of this experiment was intended to provide the necessary "semicontrol" that Zigurs mentioned was needed for further research. Additionally, the research uses the GDSS software *GroupSystems* which has been frequently used in documented field studies. This approach is particularly advantageous, since the experimental design directly compares automated (GDSS) and manual processes without the need to estimate comparisons based on historical information or previous personal experiences.

"An experiment is the premier scientific methodology for establishing causation" and is established by performing the following activities (9:419):

1. Selecting relevant variables for study.
2. Specifying levels of the various treatments.
3. Controlling the experimental environment.
4. Choosing the overall experimental design.
5. Selecting and assigning subjects to participate in the experiment.
6. Pilot testing, revising, and testing the experiment.
7. Analyzing the resulting data.

Although not necessarily discussed in precisely this order, the current experiment incorporated these activities, to the fullest extent possible for a field study.

3.2 Current Study Research Objectives

The purpose of this study was to conduct GDSS research in an Air Force environment to objectively measure and evaluate both GDSS effects and structure (facilitation) effects in real-world group decision making processes. The study evaluated two objectively measured performance outcomes: 1) effectiveness in terms of consensus, and 2) efficiency in terms of decision speed. The study also evaluated eight subjectively measured secondary outcomes relating to the user's satisfaction and perceptions. As stated in Chapter I and repeated here for completeness, the research objectives were identified by the following sub-objectives:

1. **GDSS Effects: Performance Outcomes**
   - (a) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to decision speed.
   - (b) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to consensus.
2. **GDSS Effects: Secondary Outcomes**
   - (a) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's satisfaction with the decision making process.
   - (b) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's satisfaction with the results of the decision making process.
   - (c) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of task difficulty.
   - (d) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of the group's ability to stay task-focused.
   - (e) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of productivity in terms of time efficiency.
   - (f) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of productivity in terms of ability to reach consensus.
   - (g) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of the group's level of conflict.
   - (h) Compare facilitated GDSS and non-GDSS (facilitated manual) groups with respect to the user's perception of the level of process structure.
3. **Structure Effects: Performance Outcomes**
   - (a) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to decision speed.
   - (b) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to consensus.
4. **Structure Effects: Secondary Outcomes**
   - (a) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's satisfaction with the decision making process.

(b) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's satisfaction with the results of the decision making process.

(c) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of task difficulty.

(d) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of the group's ability to stay task-focused.

(e) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of productivity in terms of time efficiency.

(f) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of productivity in terms of ability to reach consensus.

(g) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of the group's level of conflict.

(h) Compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to the user's perception of the level of process structure.

These sub-objectives were chosen because they were fairly common to most of the previous research and could be readily adapted to the real-world situation. Including so many sub-objectives allows others to easily compare the current results with previous laboratory and field studies. More importantly, the research provides information for comparison with similar future field studies which provide a reasonable amount of control and objectivity.

As part of the experimental design, the subjective portion of the research sought to measure whether groups *perceived* improved productivity in terms of time efficiency and consensus (i.e., performance outcomes), without regard to the objectively measured outcomes. This approach is important, since GDSS users may perceive an improvement in performance (or lack of improvement) when, in reality, performance may not have improved. This perception may lead them to potentially like or dislike the tool even though reality contradicts their feelings.

3.3 Field Experiment Environment Description

The Air Force conducted a two-day conference in July 1992 to develop an environmental education strategy. This conference provided an opportunity to observe and evaluate small groups making choice-type decisions. Additionally, this event provided an environment where experimental controls could be coupled with a real world decision making process. To explain, the Deputy Assistant Secretary of the Air Force for Environment, Safety, and Occupational Health tasked the Air Force Institute of Technology (AFIT) and the USAF School of Aerospace Medicine (i.e., organizations responsible for providing environmental education to USAF personnel) to develop the USAF Environmental Education Master Plan.[1] This task first required the identification of

[1] This plan is a comprehensive, integrated environmental education and training plan for all USAF professions.

critical education categories and later the levels of education/training needed for each particular Air Force profession or career field.

At the first working group in April 1992, key environmental professionals met at Brooks AFB in San Antonio, Texas and identified categories of USAF professions (reference Table 3.1) and unique environmental tasks (reference Table 3.2) which must be considered for training in these USAF occupations.[2] The next step in this process required the sponsors to identify the appropriate level of training for each environmental task against each specific USAF profession using a small group decision making process. This small group decision making process was evaluated by the current research.

Armstrong Laboratories and the sponsoring organizations collectively agreed to conduct a variant of the Nominal Group Technique/Delphi process to select the levels of training. Approximately 40 participants met in a large group setting to discuss the meaning and specific examples of the 51 environmental tasks identified in the April 92 Environmental Working Group (reference Table 3.2). Thirty-five members within this group later divided into seven groups of five members each to discuss and evaluate the level of training needed for each of the 51 tasks for each career field represented in the group. Ideally, each small group included a representative for each of four unique career fields to be evaluated.

These small groups were randomly selected to receive different *treatments* in the manner in which they conducted their meetings. The primary treatment was use of GDSS technology; however, several other variables were introduced in facilitated manual group settings in order to evaluate the effect of *structure*. Following evaluation of the 204 distinct decisions (51 tasks times 4 career fields), the small groups returned to the large group setting to discuss and resolve specific tasks for which the group did not reach consensus. The overall goal in this process was to reach consensus on the maximum number of tasks possible during the small group sessions and to reach full consensus on the remaining tasks in the large group. The research focused only on the small group process in accordance with the objectives stated previously. A task evaluation scale shown in Figure 3.1 identified the levels of training which could be assigned for each environmental task in each career field. Recalling McGrath's Task Circumplex, this type of task was a *choice* decision making task where participants made decisions for issues which have no right answer.

This conference lasted two days. Initially, on the morning of the first day, all participants met in a large group setting to discuss and further define each of 51 environmental tasks. Subsequent to that meeting, on the afternoon of the first day and the morning of the second day, the small

[2]The terms "occupations," "professions," and "career fields" are used interchangeably in this document.

Table 3.1. USAF Professions Categorized by Priority (34:Atch 2).

CATEGORY I	
Bioenvironmental Engineering	Civil Engineering/Environment Engineering
Environmental Staff Judge Advocate	Public Affairs
Logistics	Installation & Group Commanders
System Program Office Hazardous Materials Personnel	Fire Fighters
Base Disposal Personnel	Flight Medicine

CATEGORY II	
Corrosion Control	Military Public Health
Toxicologists	Systems Safety
Disaster Preparedness	Medical Treatment Facility Commanders
Materials Engineering	Process Engineering
Manufacturing Engineering	Contract Inspectors
Procurement	Fuels Personnel
Maintenance Quality Assurance/Control	Industrial Supervisors
Plating Shop Personnel	Vehicle Maintenance
Waste Treatment	Defense Reutilization & Management Office
Morale, Welfare, & Recreation	Medical Treatment Facility Plant Managers
Medical Logistics	Photo Laboratory Personnel
Pest Control	Contracting
Industrial Shop Worker	

CATEGORY III
Ground Safety
Security Police
Army Air Force Exchange Service Warehouse Worker
Real Estate
Defense Commissary Agency

Table 3.2. USAF Environmental Tasks (34:Atchs 3 & 4).

NUMBER	ENVIRONMENTAL TASK
1	Incident Response
2	Hazardous Materials (HAZMAT) Management
3	Environmental Monitoring
4	Hazardous Abatement
5	Recognition of Environmental Problems
6	Hazardous Materials Training
7	Waste Management Recycling Treatment & Disposal
8	Environmental Sampling
9	Environmental Audits/Tracking
10	Hazardous Communications (HAZCOM)
11	Installation Restoration Program (IRP)
12	Permit Management
13	Health Assessment
14	Regulatory Requirements Identification
15	Material Substitution
16	Risk Analysis Management
17	Risk Communications
18	Plans Review-Environmental Aspects
19	Environmental Project Design
20	Environmental Contracts
21	Community Involvement
22	Notice of Violations (NOV) Tracking
23	Review Pending Laws
24	Management Installation Geographically Separated Units (GSUs)
25	Environmental, Safety, and Occupational Health (ESOH) Orientation
26	Revise Environmental Technical Data
27	Clinical Evaluation and Investigation
28	Crossfeed Lessons Learned
29	Real Estate Management
30	Design Trade-Off Analysis
31	Program, Planning, and Budgeting
32	Process Assessment
33	Environmental Policy Management
34	Project Management
35	Natural and Cultural Resource Conservation
36	Dissemination of Environmental Policy to Civil Engineering (CE)/Logistics(LG)/Medical(SG)
37	Policy and Plans Management
38	Contract Management
39	Functional Responsibilities
40	Integrate into Position Descriptions (PDs), Safety Training Standards (STS), Safe & Proper Procedures (SPP)
41	Advocacy & Resource Allocation
42	Information Management
43	Records Management
44	Reuse, Recover, & Recycling
45	Technology Assessment
46	Strategic Planning
47	Interagency & Industrial Cooperative Efforts
48	Understand Acquisition & Logistics
49	Life Cycle Cost Analysis
50	Cost Benefit Analysis
51	Computer Operations Training

How Important is this Task to the Career Field?

Level 5: Task is an essential responsibility of this career field.
Level 4: Career field must understand and be able to perform this task.
Level 3: Career field must understand this task.
Level 2: Career field should have some knowledge of this task.
Level 1: Career field never performs this task and/or has no need for additional training and education in this task.

Figure 3.1. Task Evaluation Scale: Environmental Training Levels.

groups completed the decision making process of choosing what they felt were appropriate training levels for each specific AF career field. Finally, on the afternoon of the second day, the large group reconvened to review the outcomes of the small group processes.

Three of these small groups were exposed to GDSS technology, while the other four groups were exposed to only manual (facilitated or unfacilitated) processes. The current experiment captured measurements from the small group processes.

The objective of the research was to evaluate GDSS and process structure effects to the group decision making process. In order to provide a more robust study, a multi-methodological research effort was undertaken: objective measurements of the performance outcomes of decision making speed and consensus were taken by group facilitators or designated team leaders,[3] while subjective measurements of the secondary outcomes (i.e., individual satisfaction levels and perceptions) were obtained through the use of post-process questionnaires. A pre-process questionnaire was also used to measure the participant demographic characteristics.

The small groups consisted of five members: one individual to represent each of four career fields and one environmental professional. All five members participated in the small group discussions and voted for the appropriate training levels. All five people attempted to reach full consensus on the environmental task training levels. Approximately two hours were allocated for each session. The small groups were instructed to complete two career fields each day. Any tasks for which the groups did not achieve consensus were brought back to the large group the afternoon of the second day for further discussion and resolution. Small groups using GDSS technology used a decision room in a face-to-face environment as illustrated by the taxonomy provided in Figure 3.2.

[3]These were the Environmental Professionals for the unfacilitated manual groups.

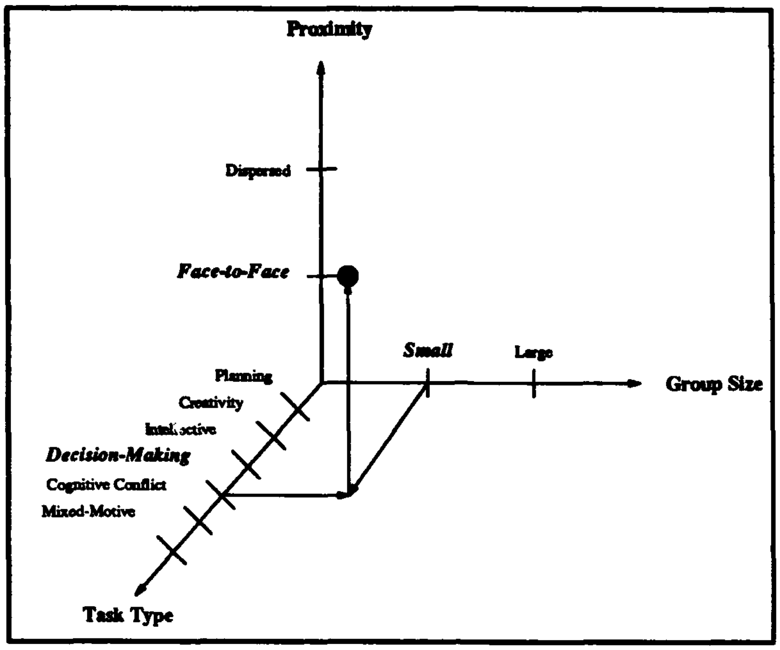

Figure 3.2. USAF Experiment Taxonomy (16:239).

3.4 Group Size and Individual Assignments

This experiment involved a small group process. Small groups have been typically classified in the literature as those with fewer than five members; however, there are differing opinions as to exactly how many members constitute a small or large group. For example, George et al state that large groups, greater than four members, tend to get more efficiency and effectiveness gains from GDSS than small groups (i.e., four or fewer members), while others clearly state that large groups are primarily those with at least five members (14:24). Essential research is needed to target the group size most pertinent to that size of groups which meet in real organizations. Watson et al quote a 1986 article in *Datamation*[4] which states that "the average number of people attending an organizational meeting is only five" (43:466). This group size condition is consistent with the experimental design of the current research; however, it should be noted that group size was determined primarily by the sponsoring organizations. The researcher sought to maintain the groups participating in the study at a uniform size.

Subjects participating in an experiment should be representative of the population being studied in order to assess generalization of the results obtained (9:421–422). Since the subjects

[4]Refers to "Hardware: Offline," *Datamation*, 32: 109 (May 15, 1986).

were drawn from many USAF professions, they represented, at least functionally, a cross section of the mainstream USAF.

The researcher was concerned that the different individual backgrounds of the participants could potentially confound the experiment's results. This concern is not unique to this study. In any experiment, the researcher attempts to negate or reduce the effects due to confounding variables. This practice can be accomplished primarily by two means: either controlling the variable or matching the variable with equal distributions across all groups (9:157). Whenever these approaches are not feasible—as in the current study—the researcher uses the process of *randomization*. Emory states that "randomization is the basic method by which equivalence between experimental and control groups is determined...random assignment to experimental and control groups is the basic technique by which two groups can be made equivalent" (9:158). What this means is that through random assignment each group would supposedly receive its fair share of different factors. Deviations experienced because of personal differences, rather than the experimental treatment, would be randomly distributed among all groups. Their effects on the dependent variables would be random, thereby minimizing "extraneous noise" and improving "sensitivity of measuring the hypothesized relationship" (9:158, 421–422). The participants were assigned to small groups by the sponsoring organizations. Individual career specialties served as the primary criteria for these group assignments. The environmental representatives were also assigned to groups by the sponsoring organizations where their backgrounds and expertise best matched the career fields represented in a particular group.

Finally, the sponsors did not select specific people to attend the conference. This decision was left to the individual commanders of the organizations represented at the conference. Another precaution was undertaken. In an experiment, whenever a variable can neither be controlled nor eliminated, at a minimum it should be measured. Since personnel assignments to the small groups were not completely random, a pre-process questionnaire was administered to all group members.

3.5 Group Participant Demographics

Prior to the small group process on the first day, all participants voluntarily completed a Pre-Process Questionnaire identical to that shown in Figure 3.3. The questionnaire served two purposes. First, it was used to characterize the demographics of the groups in terms of age, gender, rank, job experience, and education to show essentially equivalence across groups. Second, it was used to determine the "computer literacy" of the participants and to note if any particular group was computer-averse.

Pre-Process Questionnaire

*The following information will be used to characterize the individuals participating in this process.
The data you provide will be summarized and will not be attributed to any particular individual.
Your participation is strictly voluntary, but greatly appreciated.*

Please ensure that you use the following EXACT number for all questionnaires!

Group/Individual Number ________

Rank ______________ Age _____ Gender Male / Female

How long have you been assigned to your present career field? ___ Years

How long have you been assigned to your present organization? ___ Years

---

Do you use a computer regularly at work? Yes / No

Do you own a personal computer for use at home? Yes / No

Have you taken any computer-related training classes (work or home)? Yes / No

Please indicate the highest level of education you have attained (mark only one):

- ☐ High School
- ☐ Some College Courses Taken
- ☐ Undergraduate Degree
- ☐ Some Graduate Level Courses
- ☐ Graduate Degree
- ☐ PhD or MD

Please answer the following question using the scale provided below (circle only ONE number):

How comfortable are you with using a computer?

Extremely Uncomfortable	Moderately Uncomfortable	Barely Uncomfortable	Borderline	Barely Comfortable	Moderately Comfortable	Extremely Comfortable
1	2	3	4	5	6	7

How many members of your group have you worked with previously? _________

Figure 3.3. Pre-Process Questionnaire.

3.6 GDSS Equipment and Facilities (26)

The GDSS experiments were conducted at Building 434 on Wright-Patterson AFB, Ohio. This facility is managed by the USAF Armstrong Laboratories, Human Resources Directorate, under the direct control of the Logistics Research Division (AL/HRG). The GDSS facility was configured for two distinct group decision making sessions. These two areas were virtually identical decision rooms of approximately equal size, each with five networked GDSS workstations. This configuration allowed simultaneous operation of two decision rooms to support the experimental design used in this study.

Each facility was configured as shown in Figure 3.4 with five participant workstations, a technographer's workstation, a facilitator's podium, and an overhead projector/liquid crystal display with a portable public viewing screen. The facility dimensions were approximately 20 by 15 feet. The rooms were very typical in decor of other USAF conference facilities with the addition of sound-proof wall coverings, task and wash lighting, and a two-way mirror for visual, non-disruptive observations.

Each of the five participant's and the technographer's workstations were connected via a baseband local area network. The workstations ran in a client/server mode with the network server running Novell's Netware version 3.11 operating system.

The fileserver was a Dell 316LT (80386SX at 16 MHz) laptop computer with 8 Mbytes of RAM and 120-Mbyte hard disk drive. Each participant workstation was either a Dell 316LT laptop or an ABSEC NP-913 notebook (80386SX at 20 MHz) computer. Each workstation had the capability to run independently using either MS-DOS versions 4.0 or 5.0. All the participant workstations had 4 Mbytes of RAM and used an externally connected 14-inch VGA color monitor.

The technographers' workstations were either a Dell 316LT laptop or an upgraded Zenith 386DX (25 MHz) desktop personal computer. The projection capability consisted of a 3M overhead projector with a VGA-capable IN FOCUS liquid crystal display, connected directly to the technographer's workstation, and a portable overhead projection screen. The laboratories' GDSS network is designed to be relocatable in a short amount of time.[5]

[5]AL/HRG's system design provides the flexibility to support GDSS operations at any USAF user's facility. This arrangement may be one of only a handful of systems within the GDSS/GSS research community which possesses this portability.

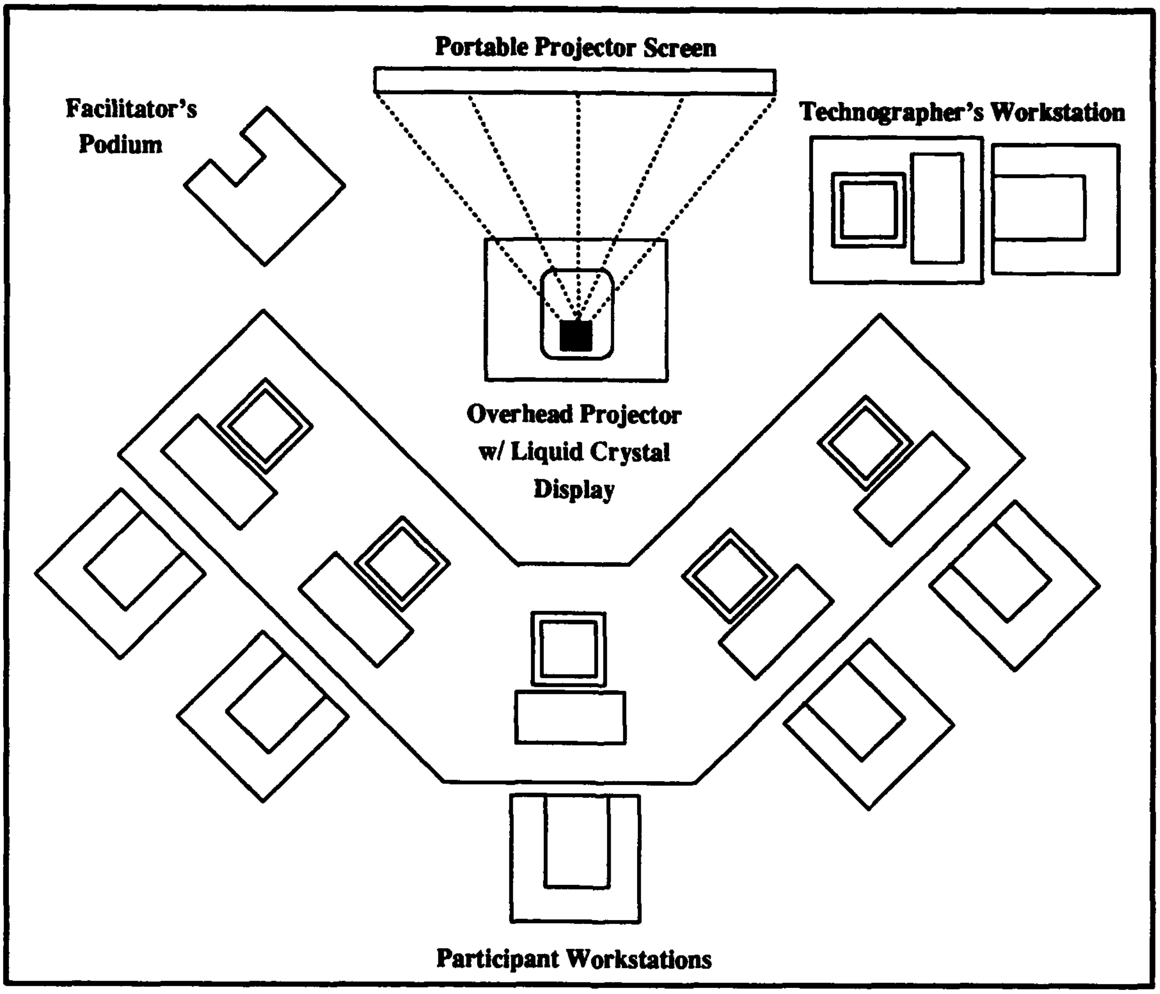

Figure 3.4. GDSS Facility Schematic for the Field Experimentation.

3.7 Non-GDSS Facilities

Facilitated-Manual groups met separately in three individual conference rooms, two at the Hope Hotel Conference Facility on Wright-Patterson AFB and one at Armstrong Laboratories. Groups 1 and 2 used the conference room at the laboratory when not using a GDSS decision room. In this manner, no group traveling to the laboratory had prior knowledge of the specific experimental condition they would receive. The conference rooms at both the laboratory and the Hope Hotel were similar in accommodations: one conference table and enough upholstered chairs for the participants and the facilitator. Groups following the traditional unfacilitated manual process met in separate areas of the large conference room or relocated to other areas within the conference center as they desired. There were no restrictions regarding where and how these unfacilitated manual process groups met, except for a few administrative details which are discussed later in this chapter.

3.8 GDSS Software Description and Procedures (40:GM126)

There has been significant criticism in the literature regarding the comparison of GDSS studies which used different software packages. The researcher for the current study chose to use Ventana Corporation's *GroupSystems V* for the GDSS portion of Experiment 1 for three reasons. First, *GroupSystems*[6] has been used almost exclusively as the tool of choice in documented GDSS field studies to date. This fact enhances the ability to make comparisons of findings with published studies. Second, *GroupSystems V* offers an excellent software utility called *Group Matrix* which is useful for compiling and publicly showing group voting results and was well-suited for this experiment's application. *Group Matrix*,[7] as the name implies, is a matrix of rows and columns which allows groups to assign relationships between row and column entities. Figure 3.5 captures a generic layout of the screen as it would appear to an individual user and the group at large. Third, Armstrong Laboratory owned a research license to this software package and was interested in conducting research using this specific software tool.

For this particular experiment, the rows in *Group Matrix* represented the four unique career fields assigned to each specific group for evaluation. The columns represented each of the 51 environmental tasks that were identical for all GDSS groups. The cell for each row/column intersection contained a selected training level. Each individual's screen showed his/her latest vote (i.e., the training level) for a specific career field/environmental task. The public screen showed the average

[6] *GroupSystems* is a registered trademark of Ventana Corporation.
[7] *Group Matrix* is a registered trademark of Ventana Corporation.

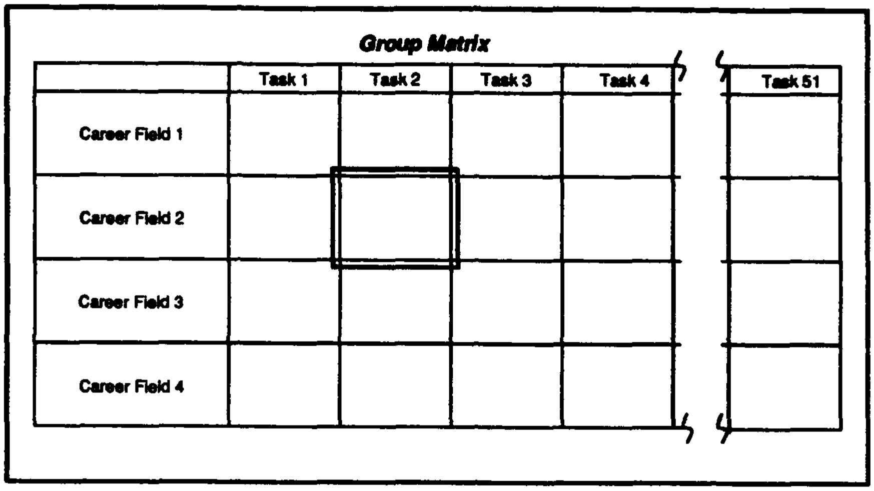

Figure 3.5. Example of a *Group Matrix* Screen (40:GM11).

of the votes (rounded to the nearest integer) of all group members for each career field/task intersection. A cell selector, indicated in Figure 3.5 as a double-lined border box, showed the current cell selected—this is how individuals selected a career field/task intersection to cast votes.

The public screen was generated from the technographer's workstation. In coordination with the facilitator, the technographer controlled when votes were cast and when the public screen was refreshed to show the latest vote tally. Once a group reached consensus for a given task, that cell was highlighted automatically in green on the technographer's display and the public screen. Prior to reaching consensus (or if non-consensus), cells which had been voted against were highlighted in red.

GroupSystems allows adjustable thresholds for consensus determination. Normally a threshold setting of one (the default) would show green if all responses were within one standard deviation of the group's mean, assuming a normal distribution. For the current experiment, the consensus threshold was set at zero (i.e., all five votes had to be identical), since the small group objective was to reach *absolute* consensus on each task for all career fields. Since *Group Matrix* updates the public screen automatically—posing a potential bias to participants who lag behind in the voting process—the technographer used the *Cell Summary* pop-up screen in order to hide the intermediate voting results. Once the facilitator had confirmed that all individuals had voted, the technographer removed the pop-up screen to reveal the group's vote. If consensus were reached, the facilitator recorded the outcome and moved the group on to vote on the next task. If not, the technographer brought up the *Cell Summary* pop-up screen which showed the distribution of votes for each task by training level. In this way, participants could see the actual distribution of votes and discuss the

rationale for the differences. This process was repeated until consensus was reached or the group had voted three times for a specific career field/task training level, whichever occurred first.

3.8.1 Training for Groups Using GDSS. Lewis et al state that "groups should not be expected to learn a new tool at the same time they are trying to solve a difficult problem, even if the tool appears quite simple...a 'hands-on' dry run is important so the group members can avoid worrying about learning the tool and focus on the problem" (21:204). George et al claim that new GDSS groups can "productively use automated [GDSS] support with five minutes or less of instruction" (14:23).

Operation of the *GroupSystems* software for the participants was relatively straightforward. The group members needed to understand how to select a career field/task intersecting cell, how to pop-up a screen which textually described each training level, and how to cast their votes. They also needed to understand how the group public screen differed from their own personal computer screen and what procedures would be followed in using the software. These topics were fully addressed at the beginning of each GDSS session as members spent 10–15 minutes rehearsing a mock voting exercise while using a matrix identical to that of the real group process. The individuals were instructed to ignore task and career field meanings during the trial runs—they were merely to practice the voting mechanism without regard for the subject matter.

3.9 Research Personnel

Five facilitators were selected from the staff of instructors at the AFIT School of Logistics and Acquisition Management. These facilitators were graduate-level instructors who were fairly experienced in facilitating group discussions. The two facilitators used for the GDSS processes were comfortable using *GroupSystems*, as they had been exposed to the software during pretest training for the current research and other academic/professional encounters. They were not, however, experienced in the technical aspects of the software's operations. The technographers provided the necessary expertise to operate the software.

The technographers were staff members of the USAF Armstrong Laboratory at Wright-Patterson AFB, Ohio. These individuals were highly trained in numerous Groupware products and were very familiar with the specific technical aspects of operating *GroupSystems*. They were primarily silent members during the actual small group processes; however, they assisted with the GDSS training prior to each group session and assisted the facilitators by operating the system and answering any technical questions.

The environmental representatives were not formal members of the research team; however, they served as team leaders for the unfacilitated manual groups. In this capacity, they accomplished record-keeping of interval times and final consensus levels during the traditional unfacilitated manual small group sessions.

3.10 Experiment Procedures

All seven groups involved in this study, regardless of experimental condition, were required to determine training levels for 51 environmental tasks for each of four career fields represented in their small groups using a voting process. The primary objective of this small group decision making process was to reach consensus on as many of the 204 tasks as possible. Those tasks for which a group did not achieve consensus would be deferred to the large group for resolution. Individuals did not know in advance to which small group they would be assigned, nor did they have prior knowledge that group process experimentation would be conducted. The facilitator for the large group session provided some general information at the beginning of the conference similar to that shown in Figure 3.6.

The procedures for all facilitators (GDSS and Facilitated-Manual) were straightforward, and strictly enforced. The goal in providing stringent procedures was to ensure that the level of structure in both GDSS and FAC-MAN groups was essentially identical. The facilitators followed the instructions in Figure 3.7 which required them to vote sequentially (one career field and one task at a time) and vote no more than three times, regardless of whether or not the group reached consensus. This restriction was a compromise between the research team and the conference sponsors to ensure that the process moved along in a timely manner while still accomplishing the research objectives.

To ensure the voting procedures were standardized, the facilitators sought an initial vote for each task prior to any group discussion.[8] Time limits for discussion were not imposed; however, facilitators were encouraged to keep the process moving. A second vote was taken. If consensus was not met, a third vote was taken without additional discussions. This process attempted to avert needless flip-flopping or swapping of two opposing votes (i.e., a "2" swaps with a "3" and vice-versa). Facilitators recorded both interval times (every ten tasks) and the distribution of votes. The distribution of votes was required to evaluate consensus during the post-experiment analysis. Finally, facilitators were requested to provide additional comments concerning group activities

[8]This procedure follows the Delphi and NGT processes.

Script for Large Group Facilitator

Today, as part of the Small Group Discussion and Voting activities, some of our AFIT people will be studying different aspects of small group processes. Your part in this effort is minimal, but very important.

All of you will be asked to fill out three very brief questionnaires which will help us to characterize the background of this whole group and also obtain some of your perceptions as they relate to the small group processes you'll be experiencing.

Please participate fully in these very brief survey instruments. Be honest and objective. Your feedback is essential towards improving workshops such as this one.

Finally, some of you will be meeting in different locations today and tomorrow for the small group activities. You have been provided with a list showing the group to which you are assigned and where and when to meet. For those identified to participate in an off-site location, please note that you will be meeting a van behind the conference center approximately 15 minutes earlier for each scheduled small group session.

Please arrive promptly at your group's designated location each day. And thanks for allowing us to use this occasion to study group processes.

Figure 3.6. Research Related Script for the Large Group Facilitator.

Instructions for Facilitators

Procedures for Group Process

Consensus voting and subsequent discussions (if needed) must be performed individually for each task per career field (i.e., one-at-a-time). Do not vote for multiple tasks all at once.

Your first vote for each task MUST precede any discussion of that task, except for clarification of the task description, if needed.

Do not vote more than THREE TIMES for any given task. VOTE-DISCUSS-VOTE-FINAL VOTE.
If consensus is not reached on the third vote, annotate the overhead acetate with the range of votes to show degree of nonconsensus. DO NOT DEVIATE FROM THIS PROCEDURE.

Make sure that FIVE people vote -- that includes the Environmental Professional.

Procedures for Data Collection

Note GROUP NUMBER, CAREER FIELD, and DATE on each Data Collection Form (IMPORTANT).

Record START, INTERVAL (every 10 tasks), and STOP times. Annotate the START time after any introductory comments or instructions--when you begin voting on task one. If your group takes a break, write down STOP and RESTART times (recommend stopping at a 10th-task mark). Use HRS/MINS/SECS..
Record each vote's consensus (at most 3 per task per career field).

Based on your observations, make any comments concerning anything which helped or hindered the the group process. Use the back of the form, if additional space is needed.

Procedures for Completing Questionnaires

Have participants fill out the Pre-Process Questionnaire FIRST before any voting commences.

Each participant has a UNIQUE GROUP/INDIVIDUAL NUMBER that must be used for every questionnaire. It does not matter who gets which number, except that each individual uses the SAME number for all questionnaires (VERY IMPORTANT).

Make sure the Environmental Professional fills out all questionnaires.

The group can not adjourn each day until after completing the Post-Process Questionnaire. Dr Wolfe's questionnaire (GDSS groups only) may be completed on the bus ride back to the Hope Center on FRIDAY.

General Instructions

Be aware of additional tasks which may have been added by the Large Group Discussion and include these on the Data Collection Form and overhead acetates.
The Environmental Professional is responsible for annotating consensus levels and nonconsensus levels (include asterisk) on the overhead acetate.
Each day you may not adjourn until two career fields have been completely voted on and the Post-Process Questionnaire is completed by all five participants.

Figure 3.7. Instructions for Facilitators: GDSS and Facilitated-Manual Groups.

which may have affected the process, either helping or hindering. All information was recorded on a Data Collection Form[9] (reference Figure 3.8).

Unfacilitated manual groups were given few instructions and, thus, were allowed to use whatever voting techniques they desired. They could meet in the large conference room or elsewhere in the conference center. The only stipulations given (reference Figure 3.9) were that they had to vote sequentially (i.e., one career field at a time, one task at a time) and the environmental representative was requested to annotate interval times on the Data Collection Form. The processes of recording final consensus levels and filling out questionnaires were straightforward.

All group facilitators and the environmental representatives (in manual groups) used the following general procedures:

1. Welcome members and allow introductions.
2. Administer pre-process questionnaires.
3. Review small group voting procedures.
4. Vote on all tasks for each career field, one career field at a time.
5. Stop voting after completing two career fields.
6. Administer post-process questionnaires.
7. Remind participants to review the schedule for the next meeting time and location.
8. Dismiss the participants.

3.11 Methodology Taxonomy

This research is similar to several laboratory experiments and field studies presented in the literature; however, it is potentially more robust in design. The approach to accomplishing the current research uses acceptable methods as noted by Vogel et al below:

> Case studies provide an opportunity to evaluate GDSS capabilities when used to address complex questions in **organizational settings with groups of experienced decision-makers**. Studies can be longitudinal as well as single session, with opportunities to capture the impact on project productivity and the organization. Accumulated case studies provide a rich source of qualitative and quantitative information in the domain of applicability of GDSS as a function of task and organizational characteristics. Surveys can be particularly useful in ascertaining opportunities for GDSS application and penetration into corporate settings. **Field study measurements include online pre- and post session questionnaires comparing the automated process to the manual process as well as systematic recording of perceptions...** (42:23–24).

[9]Each career field had its own Data Collection Form. The form shown in Figure 3.8 was condensed from three pages to one page for conciseness. The last vote, task 51, for each career field was dropped to balance the data into 20 equal intervals across all groups.

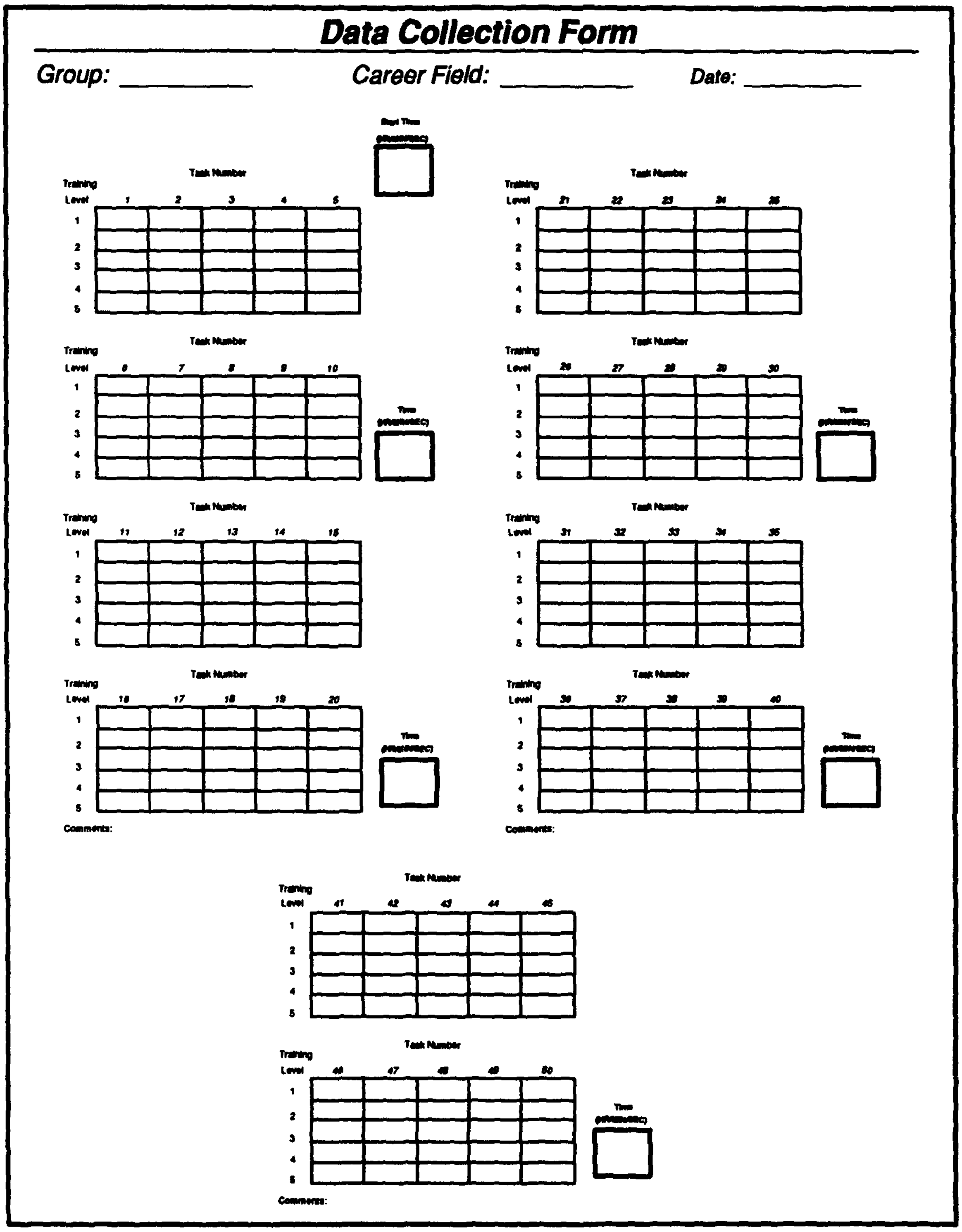

Figure 3.8. Data Collection Form for all Groups.

Instructions for Environmental Professionals

Procedures for Group Process

Consensus voting and subsequent discussions should be performed individually for each task per career field. Do not vote for multiple tasks all at once.

Make sure that FIVE people vote -- that includes the Environmental Professional.

Procedures for Data Collection

Be sure to note GROUP NUMBER, CAREER FIELD, and DATE on each Data Collection Form (IMPORTANT).

Record START, INTERVAL (every 10 tasks per career field), and STOP times. Annotate the START time after any introductory comments or instructions--when you begin voting on task one. If your group takes a break, note the STOP and RESTART times (recommend stopping at a 10th-task mark). Use HOURS, MINUTES, and SECONDS.

Record consensus/nonconsensus levels for each task.

Procedures for Completing Questionnaires

Have participants fill out the Pre-Process Questionnaire FIRST before any voting commences.

Each participant has a UNIQUE GROUP/INDIVIDUAL NUMBER that must be used for every questionnaire. It does not matter who gets which number, except that each individual uses the SAME number for all questionnaires (VERY IMPORTANT).

Make sure the Environmental Professional (that's you) also fills out all questionnaires.

The group can not adjourn each day until after completing the Post-Process Questionnaire.

General Instructions

Be aware of additional tasks which may have been added by the Large Group Discussion and annotate these on the Data Collection Form and overhead acetates.

The Environmental Professional is responsible for annotating consensus levels and nonconsensus levels (include asterisk) on the overhead acetate.

Each day you may not adjourn until two career fields have been completely voted on and the Post-Process Questionnaire is completed by all five participants.

Figure 3.9. Instructions for Environmental Professionals—Unfacilitated Manual Groups Only.

A *taxonomy* is a system for classifying related materials, species, et cetera (17:1458). Although there is no agreement on a single methodology taxonomy for GDSS research, Vogel and Nunamaker cite three candidate methodology taxonomies in "Group Decision Support System Impact: MultiMethodological Exploration." First, they identify a proposed taxonomy by Vogel and Wetherbe (1984) which consists of Theorem Proof, Engineering, Empirical (case study, survey, field test, experiment), and Subjective/Argumentative. Second, they cite the taxonomy by Jenkins (1985), the elements of which are ordered in decreasing strength in hypothesis testing: Math Modeling, Experimental Simulation, Laboratory Experiment, Free Simulation, Field Experiment, Adaptive Experiment, Field Study, Group Feedback Analysis, Opinion Research, Participative (action) Research, Case Study, Archival Research, and Philosophical Research. Finally, they identify the taxonomy proposed by Galliers and Land (1987): Theorem Proof, Laboratory Experiment, Field Experiment, Case Study, Survey, Forecasting, Simulation, Game/Role Playing, Subjective/Argumentative, Descriptive/Interpretive, Action Research (42:21–22).

Based on the previous discussion, a field experiment is, therefore, a credible method for evaluating GDSS. Perhaps not as well-controlled as the laboratory experiment, the field experiment is more robust in that it evaluates impacts in real-world situations. These types of studies are perhaps more meaningful, since experimental excellence is meaningless if users fail to recognize the usefulness of GDSS in real-life situations. Even if GDSS helps users to produce outstanding results, they may abandon its use should they become dissatisfied with either the process or the outcomes.

3.12 Field Experiment Design Characterization

For the benefit of other researchers, it is not enough to state that one is conducting field research. Many parameters are needed to characterize or describe the type of research being conducted, so that others may appreciate the specific focus and perhaps perform parallel work, follow-on work, or even a complete replication of this experiment. This research is, therefore, identified in a number of ways. The defining characteristics of this research design are summarized below and illustrated in Figure 3.10 (9:140–160):

- **Degree of Research Problem Crystallization**: This process began with a number of hypotheses for research, the goal being to test the hypotheses relating to the research subobjectives.
- **Method of Data Collection**: Observations were collected without solicitation from the participants and participant interrogation was conducted via the use of pre- and post-process questionnaires.
- **Control of Variables**: Variables were controlled and manipulated by research design. Some variables could not be controlled, but were measured if possible.

- **Purpose of Study**: The primary objective of this research was to observe interrelationships between the dependent and independent variables as a result of GDSS or process structure effects; however, some amount of descriptive study resulted.
- **Time Dimension**: This research was a "one-shot" observation; however, others may use the outcomes in a more long-term longitudinal study.
- **Topical Scope**: The approach in this study was to capture sample data, conduct statistical analyses, and draw conclusions based on the findings. The design is primarily focused on breadth, not depth, although some amount of case analysis is present.
- **Research Environment**: The research was conducted under actual environmental conditions using a real-world problem in the actual workplace.

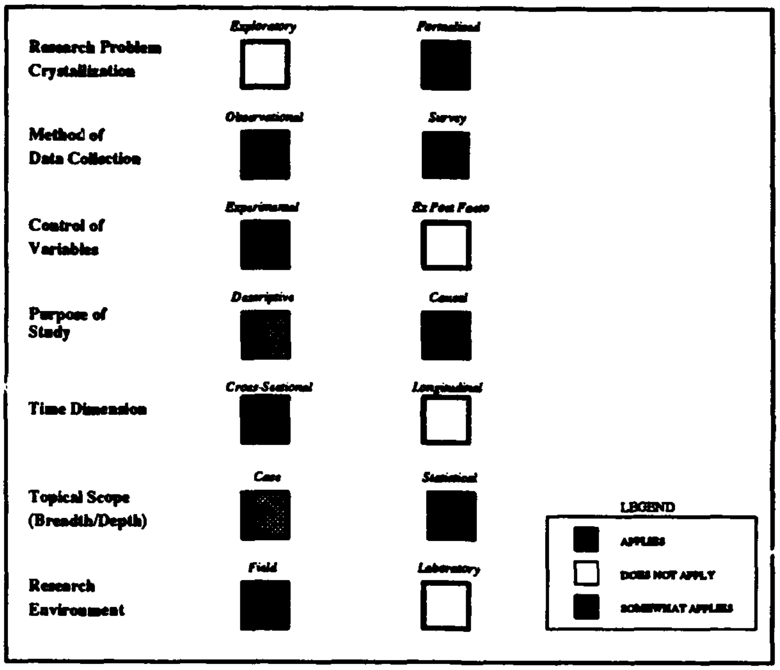

Figure 3.10. Research Design Category (9:140–160).

3.13 Experimental Design

Keeping in mind the need to account for the structure added to the small group processes, the experimental design was segregated into two parts. Referencing Figure 3.11, Experiment 1 was designed to measure GDSS effects: comparing GDSS-supported groups (GDSS) and non-GDSS facilitated manual (FAC-MAN) decision making groups. Experiment 2 was designed to measure structure effects: comparing FAC-MAN and unfacilitated manual (traditional) decision making groups. The top four blocks of each experiment show the experimental condition cross-over groups which received both the presence and absence of the treatment; whereas, the bottom four blocks of each experiment received only one level of a factor. Group 4 (in Experiment 1) and Group 7

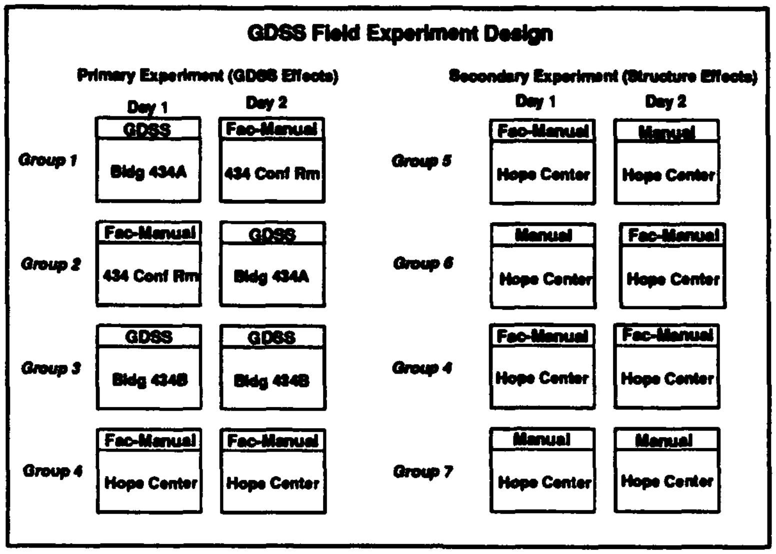

Figure 3.11. GDSS Field Experiment Design.

(in Experiment 2) were control groups. The intent in building two experiments was to separate the effects due to the GDSS from the potential effects due to the structure added to the decision making process. The groups which were exposed to a single treatment both days were needed to help account for potential learning effects which may have occurred in the experiments. This precaution was taken, since some groups were introduced to their small group conditions and the required task prior to receiving a treatment (GDSS or FAC-MAN), while others were exposed to the treatment on the first day without prior small group and task experience.

This field experiment was tailored from *factorial* experimentation; however, there are several unique differences which did not allow purely factorial experimental analysis. Ideally, the experiment could have been simplified by using a 2^2 factorial design.[10] A 2^2 or 2x2 factorial design is simpler to conduct (reference Table 3.3). It requires only four runs and can measure more than one factor at a time. In Table 3.3, a "0" represents the lower level of the factor or absence of the treatment, and the "1" represents the higher level of the factor or presence of the treatment (25:454–456), (2:306–308).

This exact model was not appropriate for this experiment for three reasons. First, the model does not take advantage of the availability of two separate days for group sessions, but if it had, it would require the addition of a third factor "day" (i.e., another independent variable). Second, real-world constraints on the conference would not allow enough training time for groups to effectively

[10] Various forms of factorial analysis have been popular in the literature for the empirical studies; however, many of these studies did not use a facilitator.

Table 3.3. 2^2 Factorial Design (25:456).

EXPERIMENTAL CONDITION	LEVEL OF FACTOR A NON-GDSS/GDSS	LEVEL OF FACTOR B UNFAC'D/FAC'D
1	0	0
a	1	0
b	0	1
ab	1	1

use GDSS without a facilitator (the design for the "*a*" experimental condition). Third, and most important, the 2x2 design does not meet the objectives of this research effort—to study GDSS and non-GDSS groups in a similarly structured manner with comparability to other on-going field studies.

A 2^3 (or 2x2x2) factorial design could have been implemented to account for Day 1 and Day 2 as two levels of an additional factor; however, real-world limitations in resources prevented this implementation. Additionally, some GDSS groups would have needed to perform without the assistance of a facilitator. Again, this approach would not meet the research objectives.

The resulting design shown in Figure 3.11 would account for the factors of interest—either presence or absence of the GDSS treatment effect (Experiment 1) and FAC-MAN treatment effect (Experiment 2). Also, the selected design was more robust, since it used more participants (35 versus 20 for a 2x2). Additionally, this design incorporated the use of control groups which experienced only one level of a given factor for both days. Although simpler to perform, factorial analysis was inappropriate for the current experimental design. The precise statistical evaluation methods are described in detail later.

Evaluating the effect of structure was an important consideration addressed in the design of this experiment. An effective comparison of GDSS to non-computer groups requires an evaluation of similar processes in addition to the processes of control groups. For this reason, the experimental design employed a manual process which provided a similar level of structure, but without the automated support. Structure was added to the appropriate treatments through use of a facilitator and simultaneous voting using numbered index cards. This approach provided practically the same level of structure as that of the GDSS groups which used *GroupSystems*. This approach also ensured simultaneous voting by the group members. That is, members were prohibited from waiting to see how others voted before they cast their vote. This latter procedure was strictly enforced throughout the experiment. The primary difference between the GDSS and the FAC-MAN groups was the lack of a public viewing screen of the Group Matrix of votes cast for the FAC-MAN groups. The

traditional unfacilitated manual groups used whatever process they deemed appropriate, but there were a few restrictions that all groups had to follow:

- Only one career field could be considered at a given time.
- Voting had to be accomplished on one task at a time (no working ahead).
- Interval times to show progress had to be recorded.
- Final consensus levels per task had to be recorded.

3.14 Group Decision Support Variables

Referring to Gray's comments on the DeSanctis and Gallupe model of group decision support variables (introduced in Chapter II), this experiment controlled or measured a number of Input Variables and Process Variables, and measured several Output Variables. The specific variables included in this study are indicated in Figure 3.12 with a small "black box" and are discussed below.

3.14.1 Input Variables.

1. **Group Factors**
   - *Group History* was presumed to be negligible; however, this variable was measured using a pre-process questionnaire to determine how many group members had previously worked together.
   - *Group Size* was controlled. Exactly five members were assigned to each group.
   - *Facilitator's Role* was controlled through use of standardized procedures which were discussed earlier.
2. **Individual Factors**
   - *Member Skills* relating to computer familiarity were measured using a pre-process questionnaire.
   - *Attitudes* concerning comfort with the use of a personal computer was measured using a pre-process questionnaire.
3. **Contextual Factors**
   - *Task Characteristics* were controlled. Only voting and discussion activities occurred.
   - *Member Proximity* was controlled as only face-to-face meetings.
   - *Time Pressure* was loosely controlled in that each group was allocated approximately two hours per session; however, groups were instructed to take whatever time was necessary to complete the tasks. Facilitators used procedures which encouraged the voting process to continue.
   - *GDSS Training/Support* was standardized as the facilitator and technographer led the groups through a 10–15 minute training session on voting procedures and assisted group members whenever difficulties or questions surfaced.

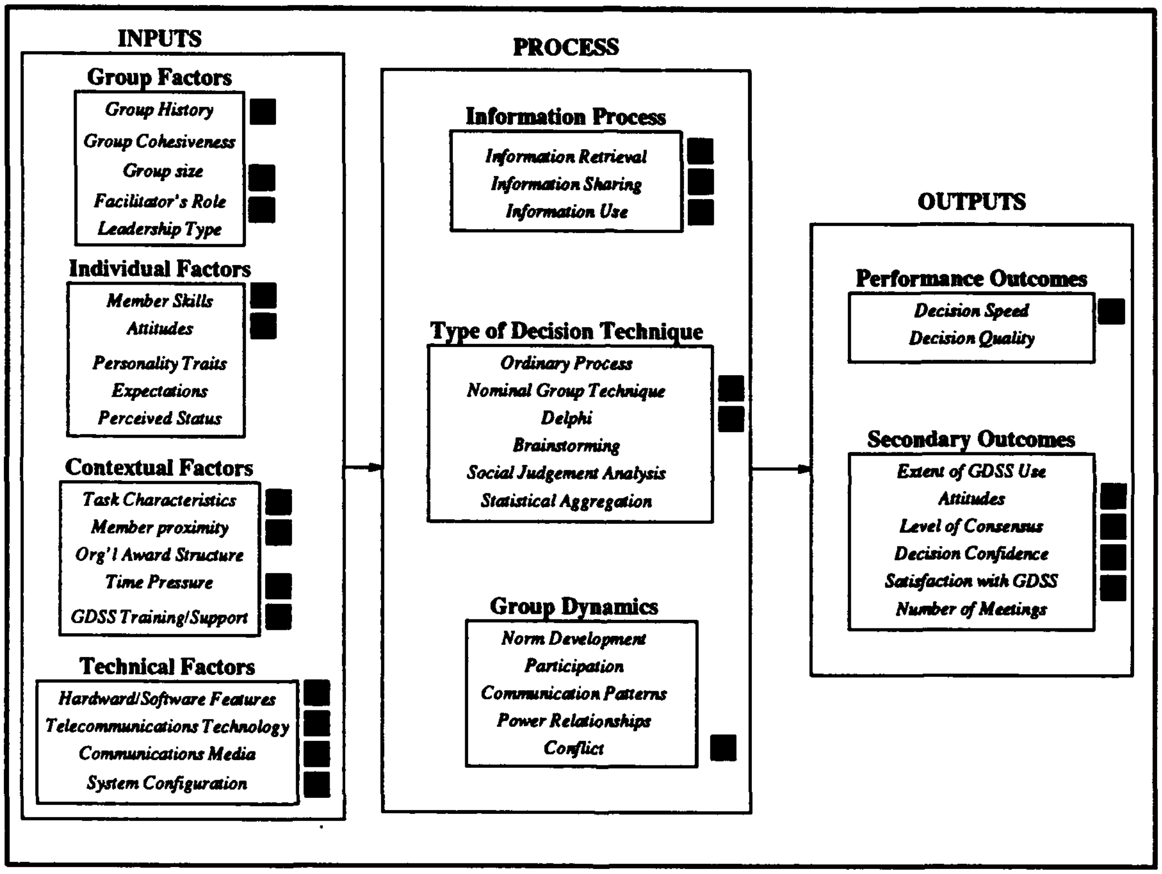

Figure 3.12. Group Decision Support Variables Included in this Experiment.

4. **Technical Factors**

   - *Hardware/Software Features, Telecommunications Technology, Communications Media,* and *System Configuration* were controlled. These factors were discussed earlier in this chapter.

3.14.2 Process Variables.

1. **Information Process**

   - *Information Retrieval, Sharing,* and *Use* were all controlled. Information pertaining to environmental tasks was detailed in the large group session. Individuals took notes and could use these notes as sources of information during the small group sessions. Two forms of automated (GDSS) information sharing, retrieval, and use were provided. Individuals had the ability to recall the definitions for the training levels (i.e., the voting criteria) and the ability to recall previous votes in the group matrix.

2. **Type of Decision Technique**

   - The experiment used attributes of both the *Nominal Group Technique* and *Delphi* processes. Members initially voted privately (NGT and Delphi), the scores were averaged (Delphi), members discussed their voting rationale publicly (NGT), members revoted privately (Delphi), and the process continued until consensus or the agreed upon three-vote restriction was reached, whichever came first.

3. **Group Dynamics**

   - *Conflict* was measured on post-process questionnaires.

3.14.3 Output Variables.

1. **Performance Outcomes**

   - *Decision Speed* was measured objectively. Facilitators recorded the interval times to complete 20 intervals, each consisting of ten decisions. Each task was completed either when consensus was reached or when three votes had been taken, whichever occurred first. The researcher also decided to measure this variable subjectively by asking participants on a post-process questionnaire how productive they felt their group was in terms of time efficiency.

   - *Level of Consensus* and the *Ability to Reach Consensus* (in terms of the number of votes cast) were measured objectively as a performance outcome. The facilitators recorded the distribution of all votes. The researcher also measured this variable subjectively by asking participants how productive they felt their group was in terms of ability to reach consensus.

2. **Secondary Outcomes**

   - *Attitudes* towards levels of process difficulty and structure, as well as the ability to stay focused on the task were measured using the post-process questionnaire.

   - *Decision Confidence* was measured on the post-process questionnaire by asking the group participants their satisfaction with the results their group produced.

   - *Satisfaction with GDSS* (and the group process) was measured using the post-process questionnaire.

- *Number of Meetings* was controlled. This was not a Secondary Outcome for this experiment. It was a Contextual Factor limited by time constraints established by the conference sponsors. Each group met exactly twice.

3.15 Questionnaire Design

This research sought to not only objectively measure performance outcomes, such as decision speed and consensus, but also to measure through more subjective means the perceptions of the participants. The most logical approach, and one used regularly in the GDSS literature, was to employ a questionnaire.[11] The current research intended to apply the multi-methodological approach espoused by Nunamaker, Zigurs, and others in the GDSS community. For example, Zigurs states that "judicious combination of multiple methods of research has the greatest potential...a consensus is forming that a multi-methodological approach provides the greatest power of understanding complex sociotechnological issues with which GSS research deals" (44:115). Zigurs explicitly recommends that a combination of quantitative and qualitative methods be used within a particular study. For this study, a very fundamental problem, inherent to the entire Information Systems discipline (of which GDSS is a subset), could not be overcome: there are no agreed upon means nor validated measuring devices for collecting qualitative data (i.e., survey instruments). Zigurs states the following (44:117):

> A real need exists for validated measurement instruments in GSS research, and authors need to provide more information about measures they are using to operationalize constructs. Most published studies reveal a dearth of information about measurement instruments used...these sample GSS articles are not all unusual in their lack of information on instrument validation.

This problem of using unvalidated survey instruments is rampant in the entire Information Systems (IS) discipline.[12] It was certainly not the intent of this research to develop and validate a survey instrument for GDSS research. That would be impossible to do under the existing field study conditions; however, the author recognizes the importance of using validated measuring devices in experimental studies.

The intent in the development of the current questionnaire was to use an ordinal scale similar to the Likert 7-point scale (reference Figure 3.13) commonly used in many research efforts and, perhaps, familiar to the prospective respondents.

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[11] The types of questions asked were similar in context to those of Jessup et al, Lewis et al, Nunamaker et al, and Gallupe et al (12:286), (18:270), (21:200), (30:190–191).

[12] Citing Straub's 1989 study, Zigurs claims that out of 117 studies, 62% lacked a single form of instrument validation. Also, Zigurs cites Zmud and Boyntons' 1989 efforts which evaluated 27 recent IS articles and found that only three of 119 examined scales met the criteria for "internal consistency, validity, and use of multiple higher-level items." Zigurs cites their conclusion that "IS survey instruments are at a very early stage of development" (44:118).

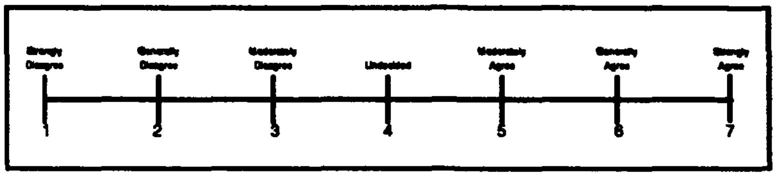


Figure 3.13. Likert 7-point Ordinal Scale.

The construction of questionnaire scales similar to the Likert scale is fairly straightforward, since there has already been a great deal of research in this area; however, the scale still possesses only ordinal properties (39:V-C Page 4). This fact makes the proper selection of response alternatives critically important. The word phrases (i.e., the adjectives and adverbs) chosen should be clear and easy to understand. That is, they should have precise meaning and possess little possibility of confusing the respondents as to whether one term denotes a higher degree of "favorableness" or "unfavorableness" (39:VIII-A, Page 1). There have been numerous studies which have determined scale values and variances for many response alternative phrases. The purpose of these scale values is to assist questionnaire developers in selecting the appropriate response alternatives—not for assigning specific values to an ordinal scale for data collection and analysis purposes (39:VIII-A, Page 1). The response alternatives should have the following properties (39:VIII-E, 1):

- Phrases with scale values as far apart as possible.
- Phrases with scale values as equally distant as possible.
- Phrases with small variability (i.e., small standard deviations).
- Phrases with parallel wording.

Selection of the scale phrases in this study were extracted from sets of response alternatives in the U.S. Army Research Institute for the Behavioral and Social Sciences' *Questionnaire Construction Manual.* These terms have been validated as being one standard deviation apart and have parallel wording (39:VIII-F, 2). These were also terms which the research team felt were far enough apart that a potential respondent could accurately discern an interval and, thus, be able to select an absolute choice.

The post-process questionnaires (reference Appendices A and B) were identically constructed in order to perform comparative statistical analysis of the responses associated with each session. There was one significant exception. The second post-process questionnaire included a section which required each respondent to compare one process to the other (refer to Page 2 of 3, Question 9 of the post-process questionnaire in Appendix B). This comparison was included for the purpose of measuring the reliability of the survey instrument used.

Finally, three open-ended questions were included so that participants could state any positive, negative, or otherwise noteworthy comments concerning their small group process. These questions provided an opportunity to gain additional insight into the results of the group processes, especially those which could be impacted by group dynamics.

3.16 Data Collection Techniques

Although *GroupSystems* has the capability to record both intermittent and final results of the consensus voting in text files, the process of saving these files would have used additional time, thereby inflating the decision speed variable. The researcher standardized the data recording process across all groups by implementing the Data Collection Form (Figure 3.8). The facilitators and environmental representatives recorded consensus levels as the small groups moved through the decision making process. The only difference in the procedure was that unfacilitated manual control groups only recorded the final vote for each task—these groups were not constrained to any particular number of votes; whereas, the GDSS and FAC-MAN groups recorded every vote, but were limited to a maximum of three votes. One limitation of this process was that unfacilitated manual groups were limited to only one of two statistical tests used for evaluating consensus.

The facilitators and environmental representatives administered the pre-process questionnaires on the first day prior to any of the decision making activities. The post-process questionnaires were administered at the end of each group session on both days. None of the personnel administering either the pre- or post-process survey instruments reported any difficulties.

3.17 Pretesting

Emory states that pilot testing the experiment's procedures and pretesting data collection instruments, such as questionnaires, can potentially reveal errors in design and improper control of extraneous or environmental conditions, as well as allow correction or refinement before actual experimental testing (9:422–423). In other words, this practice gives the experimenter one last opportunity to look for control problems which might confound the results obtained in order to revise administration procedures and data collection methods before actual use.

For this research, the experimental procedures, operation of the GDSS software and hardware, the data collection techniques, and the questionnaires were pretested prior to the beginning of the conference. All the facilitators, GDSS and FAC-MAN, participated in the development of the small group voting and data collection procedures and conducted dry-runs in either a GDSS decision room using *GroupSystems V* or a FAC-MAN conference room using voting cards. Armstrong Laboratory

staff and technographers also participated to provide an additional level of expertise and experience. Each facilitator rehearsed his responsibilities using the actual tasks for the conference with a mock five-member group. This dry run provided facilitators the opportunity to ask questions regarding the procedures to be used during the experiment. The facilitators were subsequently critiqued on both positive and negative aspects of the group process procedures that were followed.

During these pretest practice sessions, pre- and post-process questionnaires were reviewed by Armstrong Laboratory personnel and were administered to the facilitators and others participating in the exercise. No one experienced any difficulty with the word choices for the ordinal scales or questions; however, several questions were modified to improve clarity and standardization.

3.18 Statistical Analysis

The basic intent of the statistical analysis was to determine whether groups which received the higher level of a factor—presence of GDSS for Experiment 1 or facilitation for Experiment 2—exhibited significantly different results from those groups experiencing an absence of the treatment (i.e., the lower level of the factor). Although three statistical techniques were employed in this study, one method used for evaluating both performance and secondary outcomes examined the distributions of the observed data to determine whether these distributions were significantly different. For example, should the observations from GDSS groups result in a significantly different distribution compared to that of FAC-MAN groups, one would conclude that the GDSS treatment had a significant effect on the outcome variable being evaluated. Based on the results of the sample statistical tests, one could then make inferences about GDSS use in the Air Force as a whole. The process just described was accomplished using hypothesis testing.

A hypothesis is a "relational statement describing an association or dependence between two or more variables" (9:419). According to Conover, "the hypothesis is tested on the basis of the evidence contained in the sample. The hypothesis is either *rejected*, meaning the evidence from the sample casts enough doubt on the hypothesis for us to say with some degree of confidence that the hypothesis is false, or *accepted*, meaning that it is not rejected" (4:75). Typically, the hypothesis statement is actually worded in terms of a *null* hypothesis, H_o, which is usually intended to be rejected as false and an *alternate* hypothesis, H_a, which is intended to be accepted as true when H_o is rejected. For this research, H_o and H_a may be uniquely worded for a specific dependent variable being tested. Several key terms used in hypothesis testing are summarized below for conciseness:

Test Statistic. Statistic compared to a critical statistic which is used to determine the decision in hypothesis testing (4:77).

Critical Region. Set of random variables within a sample space which results in rejection of H_o (4:78).

Type I Error. Rejecting a true H_o; probability of making a Type I error equals α (4:78).

Level of Significance. Maximum probability of rejecting a true H_o; equals α (4:78).

In hypothesis testing, there are essentially two classes of significance tests: parametric and nonparametric. Parametric tests use interval or ratio measurements and are used when information about an underlying distribution is known. Nonparametric tests use nominal (classes) or ordinal (ordered) measurements; however, they are used when one can not characterize the underlying distribution. Nonparametric tests are statistically less powerful than parametric tests, but require fewer and less stringent assumptions.[13] Although some researchers have applied parametric tests for ordinal data, nonparametric tests are the only technically correct tests to use (9:529–530, 532).

3.19 Test Selection and Data Analysis Procedures

Emory states that the researcher should determine the following before selecting an appropriate statistical test (9:532):

1. How many samples are involved $(1, 2, \ldots k)$?
2. If there are two or k samples, are they independent?
3. Is the measurement scale nominal, ordinal, interval, or ratio?

Experiments (or sample sets of a population) are independent if the results of one experiment (sample) do not influence the results of another experiment (sample) (4:13). Conover and Emory describe the measurement scales identified in item three above as follows (4:64–66) (9:172–176):

Nominal Scale. Observations are assigned numbers or names in order to classify them into distinct categories.

Ordinal Scale. Observations are assigned numeric values for ordering (sizing) purposes only. Distances between numeric values may not be fixed.

Interval Scale. Observations possess relative order and distance characteristics from other observations. Distances between numeric values are equal, but the origin (or zero point) is arbitrarily chosen.

Ratio Scale. Observations are compared using a ratio measurement in addition to order and size characteristics. This scale possesses an origin which is considered as absolute zero.

The author acknowledges that, historically, GDSS researchers have frequently tested ordinal data using parametric tools in both laboratory and field GDSS studies. For example, GDSS and

[13] "Nonparametric tests often achieve 95% the efficiency of parametric tests. For example, a nonparametric test using a sample size of 100 would have the same statistical testing power as that of a parametric test with a sample size of 95" (9:532).

non-GDSS groups have been compared using either the t-test (a parametric test) to test average (mean) values from questionnaire responses (12:289–290), (13:9), (21:197). In the current research, the ordinal data was tested with strict adherence to the more acceptable nonparametric statistical methods.

Decision speed observations were ratio/interval data and were analyzed using Multiple Regression analysis. *Consensus* observations were ordinal data and were analyzed using Contingency Tables/Chi-Square test and Fisher's Exact test. Finally, the various dependent variables concerned with the user's satisfaction levels and perceptions in post-questionnaire responses were ordinal data and were analyzed using both Contingency Tables/Chi-Square test, Fisher's Exact test, and the Sign test.

Data for the performance outcomes, decision speed and consensus, were taken from the interval data recorded by facilitators (time and consensus) and environmental representatives (interval time only for unfacilitated manual groups). For convenience, only 200 of the 204 intervals were considered. In other words, the last task for each career field was dropped, since an interval was based on 10 tasks.

3.20 Analyzing Decision Speed using Multiple Regression

The researcher was interested in comparing GDSS to FAC-MAN (Experiment 1) and comparing FAC-MAN to Manual (Experiment 2) with respect to decision speed. There were a number of independent variables associated with this research. Decision speed was the dependent or response variable which could be related to any one of the independent variables. A popular method used for evaluating such relationships is multiple regression. Since both experiments were divided into 20 intervals of 10 decisions each, decision speed was actually measured in terms of the time, Y_i, to complete each of these 20 intervals.

A first order model of $p-1$ independent variables was chosen (27:229):

$$Y_i = \beta_o + \beta_1 X_{i1} + \beta_2 X_{i2} + \cdots + \beta_{p-1} X_{i,p-1} + \varepsilon_i \tag{3.1}$$

or equivalently (27:230):

$$Y_i = \beta_o + \sum_{k=1}^{p-1} \beta_k X_{ik} + \varepsilon_i \tag{3.2}$$

where β_o is the intercept, $\beta_1, \ldots, \beta_{p-1}$ are the regression coefficients for each of the independent variables, X_{ik}, ϵ_i is the error term, and p is the number of independent variables including the intercept.

Since many of the independent variables in this research were not quantitative (i.e., not numeric), indicator or dummy variables were chosen in their place (11:146). Consider Experiment 1, for example. The indicator variables helped to test the model by representing the absence of a treatment (e.g., FAC-MAN) or initial experimental condition (e.g., Day 1) with a "0" and the presence of a treatment (e.g., GDSS) or second experimental condition (e.g., Day 2) with a "1." This test was performed to determine if groups which used GDSS reached decisions faster than groups which did not use GDSS. The same procedure was followed for Experiment 2.

The model includes several variables which may account for the variability in decision speed. These variables address the differences between groups, differences between days, and learning effects associated with differences in intervals. Specifically, the model and the variables assigned to the X_i are defined below:

For Experiment 1:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$$

$X_1 =$ Group 1, where $X_1 = 1$ when Group 1 is present, else $X_1 = 0$.

$X_2 =$ Group 2, where $X_2 = 1$ when Group 2 is present, else $X_2 = 0$.

$X_3 =$ Group 3, where $X_3 = 1$ when Group 3 is present, else $X_3 = 0$.

$X_4 =$ Day, where $X_4 = 0$ for Day 1 and $X_4 = 1$ for Day 2.

$X_5 =$ Method, where $X_5 = 0$ for FAC-MAN and $X_5 = 1$ for GDSS.

$X_6 =$ Interval number (integer from 1 to 20).

Groups 1–3 are compared to the control group, Group 4, which is included in the model, but not represented as an indicator variable (i.e., the experimental condition where X_1, X_2, and X_3 all equal zero).

For Experiment 2:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$$

$X_1 =$ Group 4, where $X_1 = 1$ when Group 4 is present, else $X_1 = 0$.

$X_2 =$ Group 5, where $X_2 = 1$ when Group 5 is present, else $X_2 = 0$.

X_3 = Group 6, where $X_3 = 1$ when Group 6 is present, else $X_3 = 0$.

X_4 = Day, where $X_4 = 0$ for Day 1 and $X_4 = 1$ for Day 2.

X_5 = Method, where $X_5 = 0$ for Manual and $X_5 = 1$ for FAC-MAN.

X_6 = Interval number (integer from 1 to 20).

Groups 4–6 are compared to the control group, Group 7, which is included in the calculations, but not represented as an indicator variable (i.e., the experimental condition where X_1, X_2, and X_3 all equal zero).

The hypothesis for Experiment 1:

H_o: There is not a Statistically Significant Relationship between the Decision Method (GDSS) and Decision Speed, that is $\beta_5 = 0$.

H_a: There is a Statistically Significant Relationship between the Decision Method (GDSS) and Decision Speed, that is $\beta_5 \neq 0$.

The hypothesis for Experiment 2:

H_o: There is not a Statistically Significant Relationship between the Decision Method (FAC-MAN) and Decision Speed, that is $\beta_5 = 0$.

H_a: There is a Statistically Significant Relationship between the Decision Method (FAC-MAN) and Decision Speed, that is $\beta_5 \neq 0$.

The *Test Statistic* was the t-ratio, T, where $\alpha = .05$. This statistic is used to test the significance of the individual parameter estimates, most importantly β_5 (11:23).

The decision concerning the test statistic was to reject H_o when $T > t_{\alpha/2,\nu}$, where $\alpha = .05$, $\nu = n - m - 1$ degrees of freedom, ν is the degrees of freedom, n is the number of observed interval times, and m is the number of independent variables excluding the intercept. Equivalently, one would reject H_o when $p \leq \alpha$, where $\alpha = .05$.

This analysis was performed using PROC REG in the statistics program *SAS*. A prerequisite for regression analysis is that the observed data being evaluated are either ratio or interval (36:313). Additionally, diagnostic tests were performed to ensure that the model did not violate the assumptions of regression and to check for multicollinearity.

One such assumption is that the error terms, or residuals, are assumed to be independent and randomly distributed. In other words, there should be no correlation (or autocorrelation) of the

error terms, ε_i. Freund describes this phenomenon as errors at time t relating to previous errors, say time $t-1$. He states that if autocorrelation is ignored, the regression coefficients are subject to unknown biases (11:68). Consequently, the Durbin-Watson D statistic was calculated to determine whether or not the error terms were correlated. For this test, the hypotheses were $H_o : \rho = 0$ and $H_a : \rho > 0$, where ρ is the autocorrelation parameter (27:450-451). D values were compared to the upper (d_U) and lower (d_L) bounds for this statistic in Table A-6 of *Applied Linear Regression Models* by Neter et al at sample size n, $\alpha = .05$, and the number of independent variables, m.[14] If the test resulted in $D > d_U$, the test concluded H_o; $D < d_L$, H_a; and $d_L \leq D \leq d_U$, inconclusive (27:451). As a general rule, if the values of D are close to 2, then the errors are uncorrelated (35:1434). The randomness of the error terms were further evaluated by examining the randomness of residuals on a residual-predicted value plot.

Another assumption of regression analysis, the normality of the distribution of the residuals, was tested by implementing the Shapiro-Wilk test in *SAS*. If the correlation coefficient, W, of the Shapiro-Wilk test was greater than .9, the residuals were concluded to be normally distributed (27:120). This conclusion was also supported by examining the residuals on both Stem-Leaf and Normality Probability plots generated using *SAS*.

Outliers are observations which do not appear to fit the model, and may affect the accuracy of parameter estimates. Although they should not be eliminated from the model unless the analysis reveals that the observations were erroneous, one should attempt to account for their presence. Outliers can be readily identified using studentized residuals. Studentized residuals are the residuals divided by their standard errors. Since values exceeding 2.5 are rare in the t distribution, studentized residuals exceeding the absolute value of 2.5 should be considered as outliers (11:48-49).

Finally, the model was tested to ensure constancy, or equality, of the residual variance. This assumption was tested by ensuring that the pattern of residuals about predicted values of the dependent variable on a residual-predicted value plot was fairly random in a horizontal band about the prediction line (27:114). Also, fit of the model and the possibility of omitting critical independent variables were evaluated by checking the model's F and p statistics and examining various residual plots, respectively.

Since there were a large number of independent variables in the model, a test for multicollinearity was also performed. Multicollinearity means that there is a high degree of correlation between the independent variables, X_i. Multicollinearity occurs where the independent variables

[14]Table A-6 uses $p-1$ as the number of independent variables. This nomenclature was modified here to preclude confusion with p, the probability of rejecting a true H_o.

measure similar phenomena (11:75). Freund states that multicollinearity does not violate the regression assumptions, but it may "inhibit the usefulness of the results" (11:75). He cites three specific outcomes of multicollinearity (11:75–76):

1. No effect to the estimation of the dependent variable—The $\hat{Y}$ values are the best unbiased estimates.
2. Tends to inflate variances of the predicted values for X values not included in the sample.
3. Tends to inflate the variances of the parameter estimates. The regression coefficients could also have incorrect signs or not be judged as statistically significant.

Variance Inflation Factors (VIF) were calculated for all the independent variables. These numbers were compared to the model VIF$= 1/(1-R_i^2)$, where R_i is the coefficient of determination of the regression of the ith independent variable on all other independent variables (11:80). Any variables associated with VIF greater than that of the model VIF were considered to be more closely associated with the other independent variables than with the dependent variable. An arbitrary VIF level of 10 was chosen as a level of concern (11:80).

3.21 Analyzing Consensus using Contingency Tables/Chi-Square Test.

The objective was to determine if use of a GDSS or the presence of structure affected the variable consensus in a small group decision making process. If so, one would expect to see statistically significant differences in the distributions of observations taken from the GDSS, FAC-MAN, or Manual processes. Two statistical tests were run for consensus: 1) the ***ability to reach consensus*** in terms of the number of votes it took to obtain consensus for each task and 2) the ***level of consensus*** in terms of the number of the total tasks for which groups actually reached consensus.

The first test, ability to reach consensus, could only be performed for Experiment 1. A similar analysis between FAC-MAN and Manual groups could not be conducted due to the lack of data. Since the experiments were designed primarily to measure decision speed without placing undue constraints on the Manual experimental condition, only a final consensus level was recorded by the Manual groups. Otherwise, such restrictions could have potentially confounded the speed-related statistical results.

During the experiment, all facilitators recorded the number and distribution of votes cast for individual environmental tasks in order to perform these statistical evaluations. The following assumptions for using contingency tables were met: the outcomes of the observations were mutually independent, and each observation was categorized into exactly one class or column of the contingency table (4:154).

	Number of Votes to Reach Consensus				
	1	2	3	Never	Totals
GDSS	O_{11} E_{11}	O_{12} E_{12}	...	O_{14} E_{14}	n_1
FAC-MAN	O_{21} E_{21}	O_{22} E_{22}	...	O_{24} E_{24}	n_2
Totals	C_1	C_2	...	C_4	N

Figure 3.14. Contingency Table for Consensus Voting.

For the first test, a contingency table similar to that in Figure 3.14 was constructed for GDSS and FAC-MAN groups. Observations from each task of the voting process were later separated into distinct classes according to the number of votes required to reach consensus: "1", "2," "3," or "Never" (i.e., non-consensus).

The hypothesis for the first consensus test, Experiment 1 only, is provided below (4:154).

H_o: There is No Difference between GDSS and FAC-MAN in Relationship to the Ability to Reach Consensus, that is all probabilities in the same column are equal to each other ($p_{1j} = p_{2j} = p_{ij}$ for all $j = 1, 2, \ldots, c$).

H_a: There is a Difference between GDSS and FAC-MAN in Relationship to the Ability to Reach Consensus, that is at least two probabilities in the same column are not equal to each other ($p_{ij} \neq p_{kj}$ for some j and some pair i and k).

For GDSS, FAC-MAN, and Manual processes, the overall level of consensus was analyzed using contingency tables and the Chi-Square test. Here, the final consensus recorded for each task was analyzed for both experiments. The contingency table was constructed with observations of the task votes being placed into two classes, "Yes" and "No," which signified whether or not consensus was reached.

The hypotheses for the second consensus test, level of consensus, are provided below (4:154).

For Experiment 1:

H_o: There is No Difference between GDSS and FAC-MAN in Relationship to the Level of Consensus, that is all probabilities in the same column are equal to each other ($p_{1j} = p_{2j} = p_{ij}$ for all $j = 1, 2, \ldots, c$).

H_a: There is a Difference between GDSS and FAC-MAN in Relationship to the Level of Consensus, that is at least two probabilities in the same column are not equal to each other ($p_{ij} \neq p_{kj}$ for some j and some pair i and k).

For Experiment 2:

H_o: There is No Difference between FAC-MAN and Manual in Relationship to the Level of Consensus, that is all probabilities in the same column are equal to each other ($p_{1j} = p_{2j} = p_{ij}$ for all $j = 1, 2, \ldots, c$).

H_a: There is a Difference between FAC-MAN and Manual in Relationship to the Level of Consensus, that is at least two probabilities in the same column are not equal to each other ($p_{ij} \neq p_{kj}$ for some j and some pair i and k).

The *Test Statistic* for analyzing *r x c* tables is (25:292):

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \tag{3.3}$$

which can be shown to be equivalent to (4:159):

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{O_{ij}^2}{E_{ij}} - N \tag{3.4}$$

where O_{ij} is the observed cell frequency, E_{ij} is the expected cell frequency, and N is the total number of observations for all samples.

The following computations are required to compute the formulae in Equations 3.3 and 3.4 (4:154–155):

$$N = n_1 + n_2 + \cdots + n_j$$

$$E_{ij} = \frac{n_i \times C_j}{N}$$

$$C_j = O_{1j} + O_{2j} + \cdots + O_{ij} \qquad for j = 1, 2, \ldots, c$$

Finally, Equation 3.4 is reduced to the following equation for 2x2 tables, such as that used for test 1, ability to reach consensus (4:155):

	Response Alternative Number							
	1	2	3	4	5	6	7	Totals
GDSS	O_{11} E_{11}	O_{12} E_{12}	...	...	...	...	O_{17} E_{17}	n_1
FAC-MAN	O_{21} E_{21}	O_{22} E_{22}	...	...	...	...	O_{27} E_{27}	n_2
Totals	C_1	C_2	...	...	...	...	C_7	N

Figure 3.15. Contingency Table for Questionnaire Responses.

$$\chi^2 = \frac{N(O_{11}O_{22} - O_{12}O_{21})^2}{n_1 n_2 c_1 c_2} \tag{3.5}$$

The decision concerning the test statistic was to reject H_o when $\chi^2 > \chi^2_{\alpha,\nu}$, where $\alpha = .05$ and $\nu = (r-1)(c-1)$ degrees of freedom or, equivalently, Reject H_o when $p \leq \alpha$, where $\alpha = .05$.

3.22 Analyzing Participant Responses using Contingency Table/Chi-Square Test

Two sets of statistical tests were chosen to evaluate the statistical significance of participant's responses on the post-process questionnaires. The first test was the contingency table/Chi-Square test described earlier. For this particular test, one additional consideration is worthy of comment. For ordinal values one through seven on the questionnaire, several observed and expected frequencies were low or even zero. According to Schlotzhauer and Littell of SAS, Inc., statisticians disagree on whether to trust the results of the Chi-Square test whenever a cell's expected frequency, E_{ij}, falls below five (5). They recommend following the Chi-Square test with the more conservative Fisher's Exact Test[15], which is based on a hypergeometric distribution, to be sure the results from the Chi-Square test are correct (36:371). Mehta and Patel state "for sparse contingency tables, fairly large differences can exist between the p values generated by Fisher's Exact test and by Pearson's χ^2 test. Inferences based on the χ^2 test might, therefore, be misleading, whereas absolute reliance can be placed on the significance level generated by Fisher's Exact test" (24:432). The Fisher's Exact test was run in addition to every Chi-Square test to ensure the accuracy of the p values.

[15]Fisher developed an exact method for evaluating 2x2 contingency tables with expected frequencies too small for the χ^2 results to be fully trusted. This approach is provided by D. J. Finney in *Biometrika*, Vol 35, pp 145–156, 1948. This method has been expanded for use beyond a 2x2 contingency table in *SAS*; however, further discussion of this test is outside the scope of this research.

The contingency table/Chi-Square test procedures are identical to those of the objective measures of effect (i.e., the consensus tests) with a contingency table similar to that shown in Figure 3.15. The numbers, 1–7, in this figure indicate the classes of response alternatives given on the questionnaire's ordinal scale (reference Appendix A and B for the exact wording of the response alternatives). The hypotheses are similar to those in the consensus tests, except that they now reflect evaluation of the distribution of responses obtained from the subjective data obtained from the post-process questionnaires.

For Experiment 1:

H_o: There is No Difference between GDSS and FAC-MAN in Relationship to the *Dependent Variable of Interest.*

H_a: There is a Difference between GDSS and FAC-MAN in Relationship to the *Dependent Variable of Interest.*

For Experiment 2:

H_o: There is No Difference between FAC-MAN and Manual in Relationship to the *Dependent Variable of Interest.*

H_a: There is a Difference between FAC-MAN and Manual in Relationship to the *Dependent Variable of Interest.*

Here, the *dependent variable of interest* equates to the responses measured on the post-process questionnaires, namely: satisfaction with the results, satisfaction with the process, level of difficulty, ability to remain focused, productivity in terms of time efficiency, productivity in terms of the level of consensus, level of conflict, ability to reach consensus, and level of structure. The test statistic and decision rule remain the same for each of these tests.

3.23 Analyzing Participant Responses using Sign Test

As Conover mentions, the Sign Test is the oldest of nonparametric tests (circa 1710), and is based on a binomial test with probability of one-half, p= $\frac{1}{2}$. The Sign Test is useful for testing whether one random variable in a bivariate random sample (a pair of observations) tends to be larger than another and is especially useful for testing for trends in a series of ordinal measurements (4:122). The Sign Test has good power efficiency for small samples which is particularly important in this research (25:571). The data being tested were collected in bivariate pairs (X_i, Y_i) which met the following assumptions (4:123):

1. The bivariate random variable (X_i, Y_i) where $i = 1, 2, ..., n$ were mutually independent.
2. The measurement scale was at least ordinal within each pair.
3. The bivariate pairs were internally consistent, in that if $p(+) > p(-)$ for one pair (X_i, Y_i), then $p(+) > p(-)$ for all pairs and vice-versa.

In addition to the contingency table/Chi-Square test, the researcher had the opportunity to directly compare groups which experienced both experimental conditions using the Sign test. Instead of classifying, counting, and looking at the overall distribution of responses for individual days, here matched pairs of responses between the two experimental conditions were examined. This procedure differs from the previous test in that it considers only those groups (1, 2, 5, 6) which crossed treatments in one of the two experiments (e.g., GDSS on one day and FAC-MAN on the other for Experiment 1). All higher level treatment responses (GDSS for Experiment 1 and FAC-MAN for Experiment 2) for each questionnaire question (i.e., each dependent variable) were compared individually to the lower level of the treatment (FAC-MAN for Experiment 1 and Manual for Experiment 2) responses to determine which level had the higher response. If GDSS for Experiment 1 or FAC-MAN for Experiment 2 were rated higher, a "+" was assigned for this matched pair. If the opposite were true, a "-" was assigned. Finally, if the two responses were equal, a "0" was assigned and the total count, n, was decremented by one. The total number of pluses and minuses were summed to yield n. The total number of pluses, T, was compared to a binomial distribution at the value of n with $p = .50$ to determine if T was large enough to reject H_o at $\alpha = .05$. The null and alternate hypotheses were as follows:

For Experiment 1:

$H_o : p(+) \leq p(-)$ or GDSS $\leq$ FAC-MAN for the *Dependent Variable of Interest.*

$H_a : p(+) > p(-)$ or GDSS $>$ FAC-MAN for the *Dependent Variable of Interest.*

For Experiment 2:

$H_o : p(+) \leq p(-)$ or FAC-MAN $\leq$ Manual for the *Dependent Variable of Interest.*

$H_a : p(+) > p(-)$ or FAC-MAN $>$ Manual for the *Dependent Variable of Interest.*

Again, the *dependent variable of interest* represents the responses measured on the post-process questionnaires: satisfaction with the results, satisfaction with the process, level of difficulty, ability to remain focused, productivity in terms of time efficiency, productivity in terms of level of consensus, level of conflict, ability to reach consensus, and level of structure.

3.24 Determining Questionnaire Reliability using Sign Test

As was mentioned earlier, there exist few published, much less validated, measurement instruments in the GDSS research. As a tertiary objective, this research sought to demonstrate the reliability of the post-process questionnaires by including a comparison section on the post-process questionnaire for the second day (reference Appendix B, Questionnaire page 2-3). This section asked the participant to evaluate each dependent variable as being "higher today", "higher yesterday," or "unchanged." In this manner, this data could be compared against the actual ordinal ratings given for treatment exposures on both days. The null and alternate hypotheses were as follows:

$H_o : p(+) \leq p(-)$ or Number of Times Objective and Subjective Results Agree $\leq$ Number of Times Objective and Subjective Results Disagree.

$H_a : p(+) > p(-)$ or Number of Times Objective and Subjective Results Agree $>$ Number of Times Objective and Subjective Results Disagree.

As before, this procedure was reserved for only the groups which crossed treatments. The analysis was performed identically to that mentioned above, except here an $\alpha = .10$ was chosen. The α value was relaxed somewhat, since the risk associated with a Type I error was not as significant to the results of this study compared to that of the performance and secondary outcome objectives.

IV. Results

This chapter addresses in detail the results of the data collection efforts and subsequent statistical evaluations conducted in this study. First, specific insights into the demographics of the participants, at the group level and as a whole, are addressed. Second, a brief discussion of several complications experienced during the actual experimentation and their ramifications to this study is provided. Finally, the results of the statistical tests are discussed, along with several additional findings.

4.1 Group Participant Demographics

The researcher sought to characterize the composition of the groups by measuring specific aspects of each participant's background on a pre-process questionnaire. Appendix C provides a comprehensive listing of the questionnaire responses in tabular form. These responses are summarized below for comparison purposes.

4.1.1 Backgrounds of Group Participants. Rank, age, and years within the career field or present organization tend to show the organizational seniority and the management level of the participants. Based on the questionnaire results, the participants included in this study worked in primarily the middle management arena. Five of the 35 participants did not disclose their grade/rank, and two did not identify their gender.

Referencing Figure 4.1, the average age was 42 years. The youngest participant was 32; the oldest was 60. Group 4 was the youngest group, averaging 38.6 years; Group 2 was the oldest averaging 48.4 years.

The median rank across all groups was "Major/GS-13" (reference Table 4.1); the mode was also Major/GS-13. The lowest rank in the study was a Technical Sergeant. The highest ranking participants were a GS-15 and a Colonel. Group 2 had the highest ranking group with three Lt Colonels/GS-14s. The lowest ranking group was Group 6[1] with a median and modal rank of Captain or GS-11/12. Overall, these levels of rank are fairly typical of middle management within the USAF.

Years in both the career field and the present organization are also indicators of the level of management and the level of experience. An important fact to consider is that military members tend to move every three to four years. Consequently, the number of years in the current organization may not represent experience as accurately as the number of years in a career field.

[1] Two participants in this group did not disclose their rank.

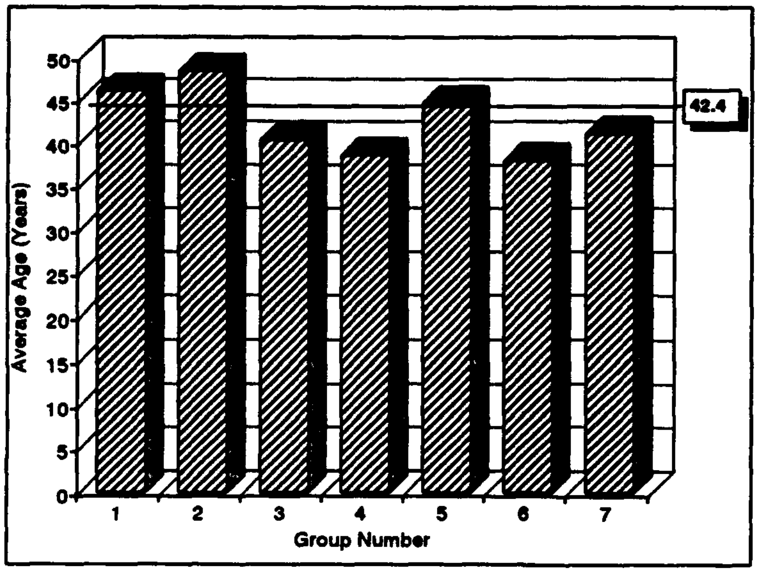


Figure 4.1. Comparison of Average Age Across Groups.

Table 4.1. Comparison of Grade/Rank Across Groups.

CIVILIAN GRADE	MILITARY RANK	INDEX	GP 1	GP 2	GP 3	GP 4	GP 5	GP 6	GP 7
Below GS-11	Below Captain	1	0	0	1	0	0	0	1
GS-11/12	Captain	2	0	1	0	1	2	2	0
GS-13	Major	3	3	1	2	3	0	0	2
GS-14	Lt Colonel	4	1	3	0	1	2	0	1
GS-15	Colonel	5	1	0	0	0	0	1	1
SAMPLE MEDIAN			3	4	3	3	3	2	3
SAMPLE MODE			3	4	3	3	2/4	2	3

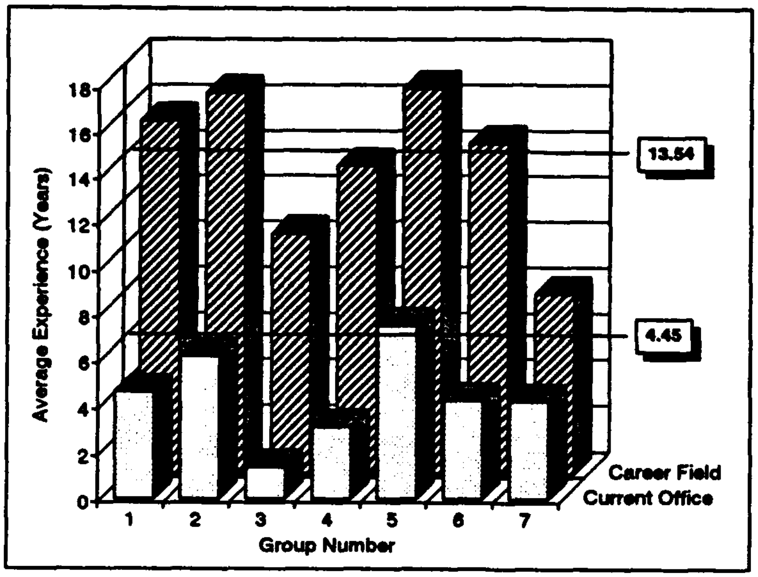


Figure 4.2. Comparison of Years of Experience Across Groups.

Referencing Figure 4.2, the average number of years in the career field and the current organization was 13.54 years and 4.45 years, respectively. Focusing on career field experience, Group 5 had the highest experience level with 16.8 years; Group 7, the lowest with 7.8 years. Except for Group 7, all groups averaged over a decade of experience in their particular line of work.

Levels of education for each of the groups are shown in Table 4.2. Most groups included members who had completed graduate-level work. The overall sample median and mode were both at the graduate degree level. Five of the thirty-five participants (14%) had a PhD or MD. Nineteen of thirty-five (54%) had a graduate degree or better, and only three individuals had not completed their undergraduate degree (8.6%). Group 1 stands out as possibly the most educated group with four graduate degrees and one PhD/MD. Groups 2 and 6 had the least educated participants.

Table 4.2. Comparison of Education Across Groups.

EDUCATION LEVEL	INDEX	GP 1	GP 2	GP 3	GP 4	GP 5	GP 6	GP 7
High School Diploma	1	0	0	0	0	0	0	0
College Courses Taken	2	0	0	1	0	0	1	1
Undergraduate Degree	3	0	1	0	1	1	0	0
Graduate Courses Taken	4	0	3	1	2	1	2	1
Graduate Degree	5	4	1	3	1	3	1	1
PhD or MD	6	1	0	0	1	0	1	2
SAMPLE MEDIAN		5	4	5	4	5	4	5
SAMPLE MODE		5	4	5	4	5	4	6

As far as gender is concerned, at least 26 out of the 35 respondents (77% of the participants) were male.[2] Two participants did not identify their gender. Two of the three GDSS groups, Groups 1 and 3, had no females, nor did Group 5. Group 2 had one female, and Groups 4, 6, and 7 all had two females. Experiment 2 included twice as many females as did Experiment 1.

Finally, it was important to determine whether or not group members knew each other. If there were groups which had previously worked together, group cohesion based on previous work experience might have confounded the data. On average, the participants knew one other member of their group. Only one person knew three members in her group (Group 7), and 13 participants (37%) did not know anyone in their group.

With the exception of gender, all the groups appeared evenly balanced with respect to the previously mentioned demographic variables. The groups appeared fairly experienced in terms of education and time in the career field. In terms of age and rank, the participants came primarily from middle management. Group 7 was the exception in two respects. First, this group had the lowest experience level in the career field with 7.8 years—almost half the overall average of 13.5 years. Second, the members in Group 7 knew more members in their group than any other group. For example, one member knew three of the other four members, and two members knew two of the other four members. Each member in this group knew on average twice as many group members as did other group's members.

4.1.2 Familiarity with Computers/Affinity Towards Computers. Before the study began, the researcher wanted to determine the computer experience levels of the participants, as well as their "comfort levels" in using a personal computer (PC). Figure 4.3 provides a good overview of the responses concerning experience levels with PCs. Most of the participants (91%) used a computer at work, while 83% had computer training, and 60% actually used a PC at home. These figures reflect a high degree of familiarity with computer technology.

Knowledge of the comfort levels was needed to determine whether or not any participants were computer averse. The participants' "comfort" level with computer technology was actually fairly high. The overall sample median was "moderately comfortable" (the second highest response level), and the most frequent response was "extremely comfortable" (reference Table 4.3). A more important aspect in this area, though, was the evaluation of the comfort level of those groups which were exposed to the GDSS.

[2] Thirty-three people (94%) responded to this question.

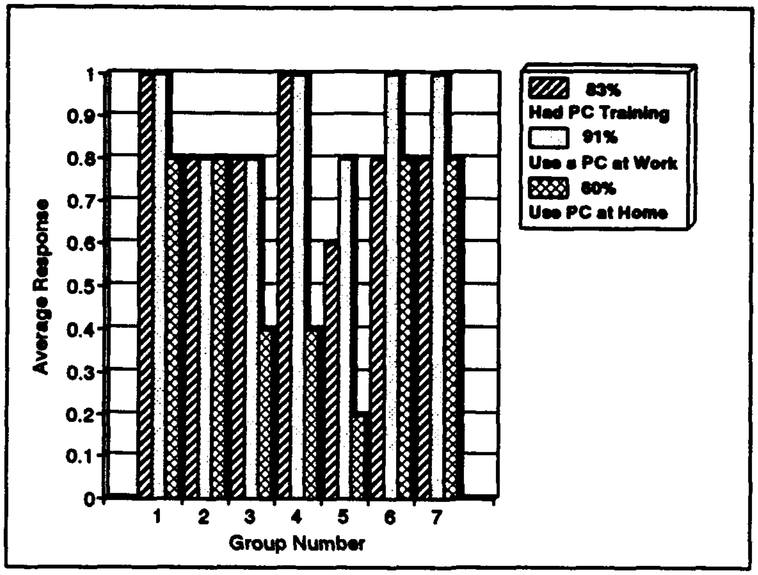


Figure 4.3. Comparison of Computer Familiarity Across Groups.

Groups 1, 2, and 3 used a GDSS as part of Experiment 1. Substantial affinity or aversion to computers in these three groups could have potentially confounded the experiment's results. None of these three groups were considered computer-averse as indicated by the median and modal values provided in Table 4.3. Group 1 had the highest comfort levels, and Groups 2 and 3 were roughly equivalent.

Table 4.3. Comparison of Comfort Using a PC Across Groups.

COMFORT LEVEL	INDEX	GP 1	GP 2	GP 3	GP 4	GP 5	GP 6	GP 7
Extremely Uncomfortable	1	0	0	0	0	1	0	0
Moderately Uncomfortable	2	0	0	1	0	0	0	0
Barely Uncomfortable	3	0	0	0	0	0	0	0
Borderline	4	0	2	1	0	0	0	0
Barely Comfortable	5	1	0	0	1	1	0	1
Moderately Comfortable	6	1	2	2	1	3	2	1
Extremely Comfortable	7	3	1	1	3	0	3	3
SAMPLE MEDIAN		7	6	6	7	6	7	7
SAMPLE MODE		7	4/6	6	7	6	7	7

4.2 Complications in the Experimental Process

There were several complications which arose during the actual experimental process. They are described below.

- As part of Experiment 1 on both days, one of the two GDSS facilitators abandoned the structured process after completing only one career field (i.e., 50 of 100 decisions each day). This action was taken for real world expediency reasons—to complete all the decision tasks within a reasonable amount of time.[3] This action meant that observations from intervals 6–10 for Group 1 and intervals 16–20 for Group 2 were not recorded and, therefore, could not be used in the decision speed analysis. The sample size for the consensus analysis in Experiment 1 was reduced, accordingly. There was no way to determine whether this action confounded the subjective measures obtained from participant's responses on the post-process questionnaire.

- On Day 2, Group 4 could not distinguish between the Procurement and Contracting career fields. They considered them to be one-in-the-same; consequently, this group did not vote on their last career field. As before, this resulted in loss of comparison data (i.e., 50 decisions) for intervals 16–20 for the decision speed and consensus analyses for both Experiments 1 and 2. Again, there was no way of knowing if this action confounded the Group 4 responses on the post-process questionnaire.

- The facilitator for Group 2 did not record interval times for the first five intervals on Day 1 (i.e., Career Field 1), but did so for the remaining 15 intervals. This event also resulted in the loss of comparison data (i.e., 50 decisions) for decision speed only. Consensus data was unaffected.

- An inadvertent assignment of different facilitators (i.e., SI and EM) to Group 4, the control group for Experiment 1, between the two days could have confounded the decision speed interval data. The original intent was to maintain the same facilitator for this control group for both days to preclude introducing different facilitator effects. Plotting the equations for SI and EM observations (reference Figure 4.4) over the entire first day's experiment (intervals 1–10) reveals two practically identical curves, as shown in Figure 4.5, with a correlation coefficient of $r = .96371$. From the data presented, SI and EM 1–10 interval times were practically identical. Consequently, SI-EM facilitator effects for intervals 1–10, and therefore this discrepancy, were deemed negligible. The *SAS* correlation data along with the equations for the curves, calculated using *Mathematica*, are provided in Appendix D.

[3] The primary objectives of the conference took precedence over the research objectives.

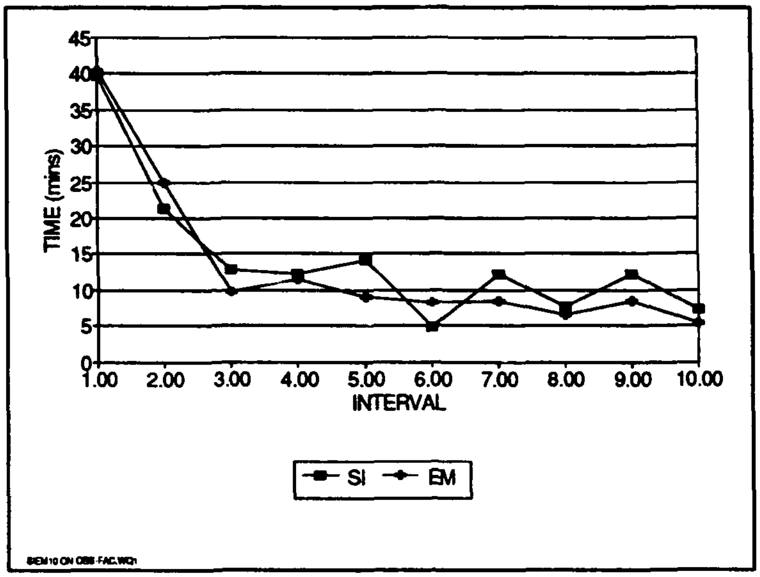


Figure 4.4. SI-EM Observations for Intervals 1–10.

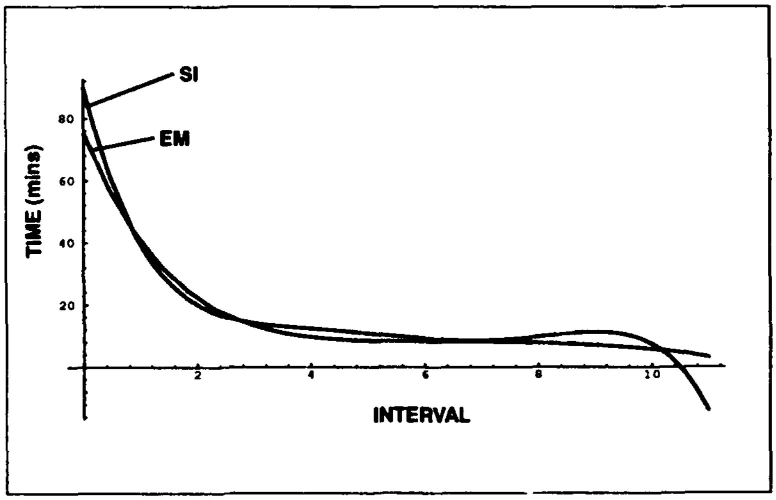


Figure 4.5. SI-EM Fitted Curves for Intervals 1–10.

4.3 Results of the Statistical Analysis on Performance Outcomes

The first performance outcome variable evaluated was Decision Speed. Decision speed was tested in terms of the time observed to complete each of the 20 decision intervals. The final regression model for the two experiments met the assumptions outlined earlier in Chapter III: homoscedasticity, no error autocorrelation, and residual normality. The final model was also evaluated for multicollinearity and the presence of outliers. The recorded interval times for both experiments are provided in Appendix E, and a compilation of the applicable *SAS* results are provided in Appendix F.

In order to test the regression assumptions and arrive at a final model for decision speed, several interim models were first considered. Four models were evaluated for Experiment 1, and two were evaluated for Experiment 2. The models evaluated for Experiment 1 are defined as follows:

- Model 1A: Decision Speed = Intercept + Group + Method + Interval + Error
- Model 1B: Decision Speed = Intercept + Group + Method + Interval + Facilitator + Error
- Model 1C: Decision Speed Transformed = Intercept + Group + Method + Interval + Error
- Model 1D: Decision Speed Transformed = Intercept + Group + Method + Interval + Facilitator + Error

The models evaluated for Experiment 2 were defined as follows:

- Model 2A: Decision Speed = Intercept + Group + Method + Interval + Error
- Model 2B: Decision Speed Transformed = Intercept + Group + Method + Interval + Error

Models 1C and 2B, both using transformed observation data, were ultimately selected as the final regression models. The following discussion addresses the assumptions which were tested, leading up to the selection of the final regression models.

Regression analysis assumes a finite variance for the distribution of residuals, the error terms, which should be constant for all values of the independent variables. This "constancy" of the residual variance is called homoscedasticity (27:183). Examining the distribution of the residuals for both experiments (reference the residual-predicted value plots in Appendix F) revealed that the residual variance increased as the decision time increased. This condition was interpreted as residual heteroscedasticity. Consequently, the observations were transformed using a square root transformation which did, in fact, stabilize the residual variance (27:132–138). Specifically, this procedure reduced the variance associated with the larger interval times more than the variance associated with the smaller interval times, ultimately correcting the heteroscedasticity observed in the original models (i.e., models 1A and 2A). For example, the plot of residuals against predicted values showed a random scattering of the residuals in a horizontal band about the prediction line, meaning constancy of the residuals. Additionally, this plot confirmed that neither of the models required quadratic terms.

The Durbin-Watson D test for autocorrelation was performed, and the D statistic exceeded the upper bound d_U for every model before and after the data transformation (reference Table 4.4). Following transformation of the data, the D-W d statistic improved, exceeding 2.0—a clear indication of no autocorrelation.

Table 4.4. Results of Regression Analysis: Assumptions Concerning Residuals.

MODEL	DURBIN-WATSON D/d_U	RESIDUAL AUTO-CORRELATION?	SHAPIRO-WILK	RESIDUAL NORMALITY?	RESIDUAL HOMO-SCEDASTICITY?
1A	1.933/1.81	No	.9105	Yes	Questionable
1B	1.988/1.85	No	.9014	Yes	Questionable
1C	2.027/1.81	No	.9667	Yes	Yes
1D	2.134/1.85	No	.9603	Yes	Yes
2A	1.961/1.80	No	.9074	Yes	Questionable
2B	2.219/1.80	No	.9736	Yes	Yes

The residuals for both experiments were normally distributed—the Shapiro-Wilk statistic exceeded .9 for every model (reference Table 4.4). Since the presence of outliers increased the skewness and kurtosis of the residual distribution, transformation of the data reduced these effects.

Additional diagnostic procedures, such as studentized residuals, normality probability plots, and residual-predicted value plots, revealed the presence of outliers in the data. Two or three high value outliers (i.e., studentized residuals greater than +2.5) were detected. These extreme values become readily apparent when viewed on a time series line plot of the various groups.[4] Referencing Figure 4.6 for Experiment 1 and Figure 4.7 for Experiment 2, the data points corresponding to these outliers are easily seen: Group 1 at Interval 2, Group 2 at Interval 11 (i.e., the first interval of Day 2), and Groups 4, 5, 6 at Interval 1. These spikes in the decision time series plots are assumed to be indications of learning effects, as the group members were being introduced to a new group decision making process. Consequently, they were retained in the model. Although there were several low value outliers (i.e., studentized residuals less than -2.5), there presence did not appear to be erroneous, and they were also retained in the model.

An independent variable for the facilitator was added to determine its effect on the model for Experiment 1 (i.e., models 1B and 1D). The p-value for this variable was not statistically significant ($p = .4370/.2272$, $\alpha = .05$), and its inclusion in the model resulted in a significant level of multicollinearity (reference Table 4.5 and Appendix F). The presence of the facilitator term appeared to be measuring the same phenomena as that of the group variables. Also, the presence of the facilitator variable had little effect on the p-value for the GDSS method being tested. For

[4]Discontinuities in the line plots are due to data being lost during the experimentation, as addressed in *Complications in the Experimental Process*. An anomylous feature of these plots is the inclusion of a line drawn to or from the x-axis whenever data is lost or restored, respectively. The reader should not interpret the data as zero values, but should ignore these lines.

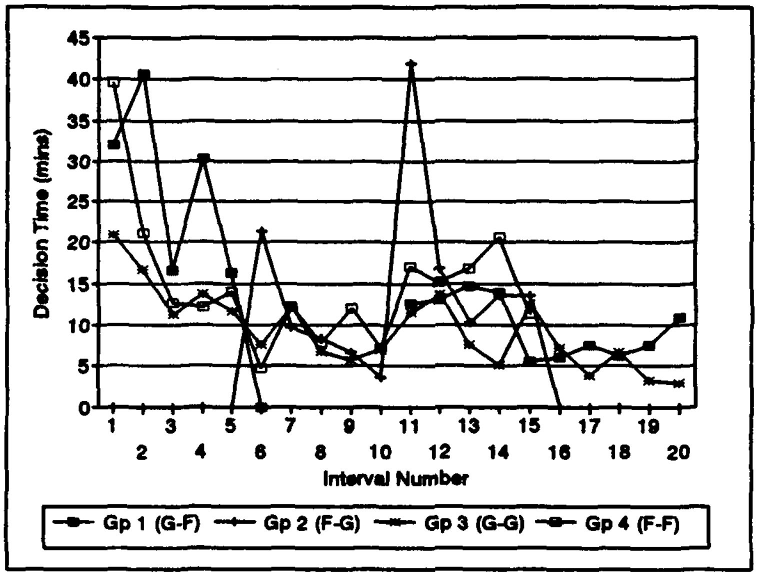


Figure 4.6. Time Series Plot of Decision Time for Experiment 1.

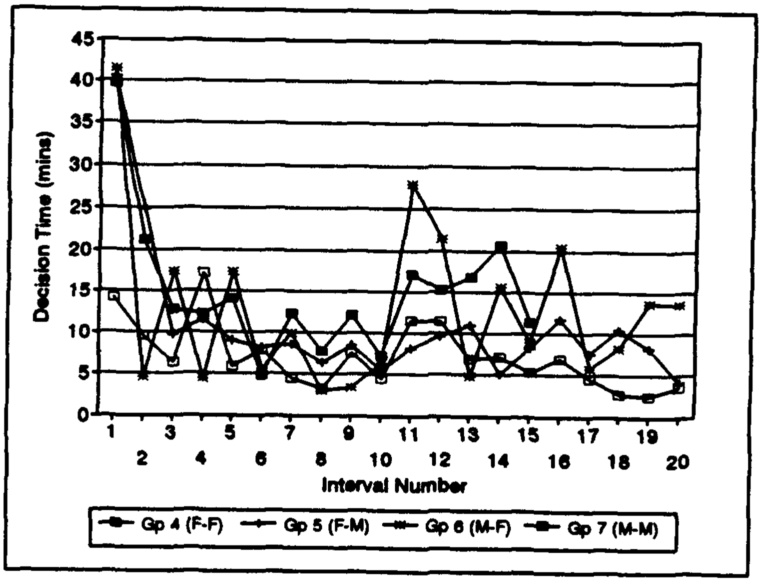


Figure 4.7. Time Series Plot of Decision Time for Experiment 2.

these reasons, the facilitator variable was dropped from consideration in the regression model. No other independent variable in the remaining models had an appreciable amount of multicollinearity.

Table 4.5. Results of Regression Analysis: Multicollinearity.

MODEL	MODEL VIF	HIGHEST INDEP VARIABLE VIF	SIGNIFICANT MULTICOLLINEARITY?
1A	2.5265	4.7168	No
1B	2.5562	32.6882	Yes
1C	3.0230	4.7168	No
1D	3.1104	32.6882	Yes
2A	1.7655	2.6346	No
2B	1.9535	2.6346	No

4.3.1 Decision Speed.

4.3.1.1 Experiment 1, GDSS Effects. The research objective was to compare GDSS and non-GDSS (facilitated manual) groups with respect to decision speed to evaluate GDSS effects. Decision speed was measured in terms of the time to complete intervals consisting of 10 decisions each. Regression analysis using indicator variables was used. The hypotheses were:

H_o: There is not a Statistically Significant Relationship between the Decision Method (GDSS) and Decision Speed.

H_a: There is a Statistically Significant Relationship between the Decision Method (GDSS) and Decision Speed.

The null hypothesis was rejected ($p = .0096$, $\alpha = .05$), and it was concluded that there was a significant relationship between the decision making method, facilitated GDSS, and decision speed. It took facilitated GDSS groups longer to complete the decision making tasks than facilitated manual groups. The regression analysis results for GDSS effects on decision speed and all regression coefficients are shown in Table 4.6 and Appendix F.[5] [6]

4.3.1.2 Experiment 2, Structure Effects. The research objective was to compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to decision speed to

[5] Concerning the interpretation of the parameter estimates, recall that this regression analysis used indicator variables for the groups in comparison with a control group (i.e., Group 4). For this reason, no parameter estimates are provided for the control group.

[6] Although regression analysis was not used here to provide a validated prediction model, the model does provide a good fit (reference Appendix F). Predicted values for decision time can be obtained by substituting the values for the independent variables into the prediction regression model, Y', and squaring the result. The answer will be in the original units of minutes.

Table 4.6. Results: Experiment 1, Decision Speed—Regression Analysis.

VARIABLE	PARAMETER ESTIMATE	|T| for H_o $\beta_i = 0$	p Value	DECISION
Intercept	5.0041	20.470	.0001	Reject H_o
Group 1	-0.0707	0.264	.7930	Fail to Reject H_o
Group 2	-0.2496	0.790	.4330	Fail to Reject H_o
Group 3	-1.3064	3.371	.0014	Reject H_o
Day	-0.5663	3.187	.0024	Reject H_o
Interval	-0.2265	6.800	.0001	Reject H_o
Method	0.8007	2.687	.0096	Reject H_o

evaluate structure effects. Decision speed was measured in terms of the time to complete intervals consisting of 10 decisions each. Regression analysis using indicator variables was used. The hypotheses were:

H_o: There is not a Statistically Significant Relationship between the Decision Method (FAC-MAN) and Decision Speed.

H_a: There is a Statistically Significant Relationship between the Decision Method (FAC-MAN) and Decision Speed.

The p-value for the FAC-MAN method actually improved (from .0658 to .0265) as a result of the transformation process. The null hypothesis was, therefore, rejected (p = .0265, α = .05), and it was concluded that there was a significant relationship between the decision making method, facilitated manual, and decision speed. It took facilitated manual groups longer to complete the decision making tasks than unfacilitated manual groups. The regression analysis results for FAC-MAN effects on decision speed and all regression coefficients are shown in Table 4.7 and Appendix F.[7]

4.3.2 Consensus.

4.3.2.1 Experiment 1, GDSS Effects. The research objective was to compare GDSS and non-GDSS groups with respect to consensus to evaluate GDSS effects. Two statistical procedures were performed examining: 1) the ***level of consensus*** in terms of the number of the total tasks for which the group actually reached consensus, and 2) the ***ability to reach consensus*** in terms of the number of votes it took to obtain consensus for each task. The distributions between GDSS

[7]Concerning the interpretation of the parameter estimates, recall that this regression analysis used indicator variables for the groups in comparison with a control group (i.e., Group 7). For this reason, no parameter estimates are provided for the control group.

Table 4.7. Results: Experiment 2, Decision Speed—Regression Analysis.

VARIABLE	PARAMETER ESTIMATE	|T| for H_o $\beta_i = 0$	p Value	DECISION
Intercept	3.7554	13.826	.0001	Reject H_o
Group 4	0.4178	1.127	.2636	Fail to Reject H_o
Group 5	0.2833	1.013	.3147	Fail to Reject H_o
Group 6	0.4715	1.686	.0964	Fail to Reject H_o
Day	-0.1159	0.625	.5339	Fail to Reject H_o
Interval	-0.2022	6.286	.0001	Reject H_o
Method	0.5676	2.269	.0265	Reject H_o

and FAC-MAN were compared to determine whether or not a significant difference existed. A contingency table was developed with two classes of consensus: "Yes" consensus was reached, and "No" consensus was not reached. Chi-Square and Fisher's Exact tests were performed, and the hypotheses were:

H_o: There is No Difference between GDSS and FAC-MAN in Relationship to the Level of Consensus.

H_a: There is a Difference between GDSS and FAC-MAN in Relationship to the Level of Consensus.

The null hypothesis concerning level of consensus was rejected (p = .042, α = .05), and it was concluded that the level of consensus between facilitated GDSS groups and facilitated manual groups was not the same. The level of consensus in facilitated GDSS groups was proportionally lower than facilitated manual groups. The contingency table for Experiment 1 was based on facilitated GDSS groups reaching consensus for 276 of 300 (92%) tasks; whereas, facilitated manual groups reached consensus for 526 of 550 (96%) tasks. Table 4.8 provides the statistical results. Recorded consensus data is provided in Appendix G. Contingency tables/Chi-Square test results are provided in Appendix H, and Fisher's Exact test results are provided in Appendix I.

Table 4.8. Results: Experiment 1, Level of Consensus—Chi-Square Analysis.

T VALUE	$\chi^2_{\alpha,\nu}$	χ^2 p VALUE	FISHER'S EXACT p VALUE	DECISION
4.818	3.841	0.028	0.042	Reject H_o

The second statistical procedure concerning Ability to Reach Consensus compared the distributions for the number of votes it took groups to reach consensus. A contingency table was developed with four classes of the number of votes required to reach consensus for each task: "1"

vote, "2" votes, "3" votes, or they "Never" reached consensus. Chi-Square and Fisher's Exact test were performed, and the hypotheses were:

H_o: **There is No Difference between GDSS and FAC-MAN in Relationship to the Ability to Reach Consensus.**

H_a: **There is a Difference between GDSS and FAC-MAN in Relationship to the Ability to Reach Consensus.**

The null hypothesis for the ability of a group to reach consensus was rejected ($p = .0006$, $\alpha = .05$), and it was concluded that the ability to reach consensus between facilitated GDSS and facilitated manual groups was not the same. Proportionally, facilitated manual groups reached consensus in fewer votes than did facilitated GDSS groups. Since the initial vote for all groups was merely a starting point, no statistical significance was placed on this vote. However, the second vote does indicate the ability to reach consensus. The data from the contingency tables showed that facilitated manual groups converged to consensus on the second vote more frequently (287 of 550 tasks or 52%) than did facilitated GDSS groups (120 of 300 tasks or 40%). The proportion of tasks where groups reached consensus on the third vote were similar between the experimental conditions. The proportion of tasks where GDSS groups failed to reach consensus was twice that of facilitated manual groups (8% versus 4%). Table 4.9 provides the statistical results. Recorded consensus data is provided in Appendix G. Contingency tables/Chi-Square test results are provided in Appendix H, and Fisher's Exact test results are provided in Appendix I.

Table 4.9. Results: Experiment 1, Number of Votes to Consensus—Chi-Square Analysis.

T VALUE	$\chi^2_{\alpha,\nu}$	χ^2 p VALUE	FISHER'S EXACT p VALUE	DECISION
17.268	7.815	.001	.0006	Reject H_o

4.3.2.2 Experiment 2, Structure Effects. The research objective was to compare facilitated manual (FAC-MAN) and unfacilitated manual groups with respect to consensus to determine if structure effects influenced the extent to which groups reached consensus. The statistical procedure examined the *level of consensus* in terms of the total tasks for which the group actually reached consensus. The distributions between GDSS and FAC-MAN were compared to determine whether or not a significant difference existed. A contingency table was developed with two classes of consensus: "Yes" consensus was reached, and "No" consensus was not reached. Chi-Square and Fisher's Exact tests were performed, and the hypotheses were:

H_o: **There is No Difference between FAC-MAN and Manual in Relationship to the Level of Consensus.**

H_a: **There is a Difference between FAC-MAN and Manual in Relationship to the Level of Consensus.**

The null hypothesis for level of consensus was rejected (p = .0006, α = .05), and it was concluded that the level of consensus between facilitated manual and unfacilitated manual groups was not the same. The level of consensus in facilitated manual groups was proportionally lower than unfacilitated manual groups. The contingency table for Experiment 2 was based on facilitated manual groups reaching consensus for 526 of 550 (96%) tasks; whereas, unfacilitated manual groups reached consensus for 397 of 400 (99%) tasks. Table 4.10 provides the statistical results. Recorded consensus data is provided in Appendix G. Contingency Tables/Chi-Square test results are provided in Appendix H, and Fisher's Exact test results are provided in Appendix I.

Table 4.10. Results: Experiment 2, Level of Consensus—Chi-Square Analysis.

T VALUE	$\chi^2_{\alpha,\nu}$	χ^2 p VALUE	FISHER'S EXACT p VALUE	DECISION
10.951	3.841	0.001	0.0006	Reject H_o

4.3.3 Discussion.

4.3.3.1 Decision Speed. Referencing Figures 4.8 and 4.9, it was interesting to note that whenever a group transitioned from unfacilitated manual to facilitated manual or from facilitated manual to facilitated GDSS, decision time increased dramatically, without exception. Transitions in the opposite direction did not experience such an increase. For example, in Figure 4.9 Group 6 transitioned from Manual to FAC-MAN with a dramatic increase in decision time (see points "c" to "d"), but Group 5's decision time did not respond to the same degree when moving from FAC-MAN to Manual (see points "a" to "b"). Likewise, in Figure 4.8 Group 2 experienced a significant increase in decision time when transitioning from FAC-MAN to GDSS (see points "c" to "d"). Group 1, however, did not experience any increase moving from GDSS to FAC-MAN (see points "a" to "b"). Each time a group experienced either the GDSS or FAC-MAN experimental conditions, initial training was provided to explain the procedures and to conduct a trial run. The time used for this training period was not included in any of the interval data. One might have expected a slight increase in time for GDSS groups to become familiar with the operation of a computer; however, it was less clear why decision time increased for groups transitioning to a facilitated manual process which used voting cards.

The results from the regression analysis showed that facilitated GDSS groups were slower than facilitated manual groups which, in turn, were slower than unfacilitated manual groups. There is a clear indication that process structure did adversely affect decision speed; however, group

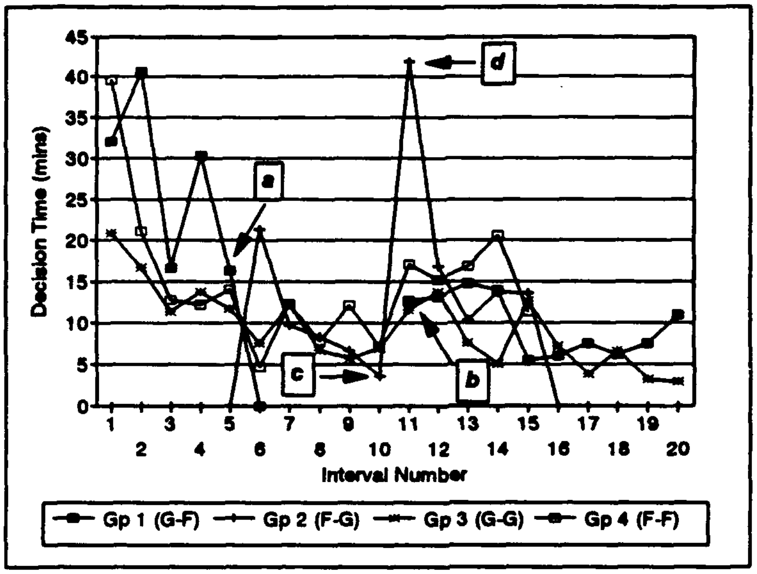


Figure 4.8. Transitions in Experimental Condition for Experiment 1.

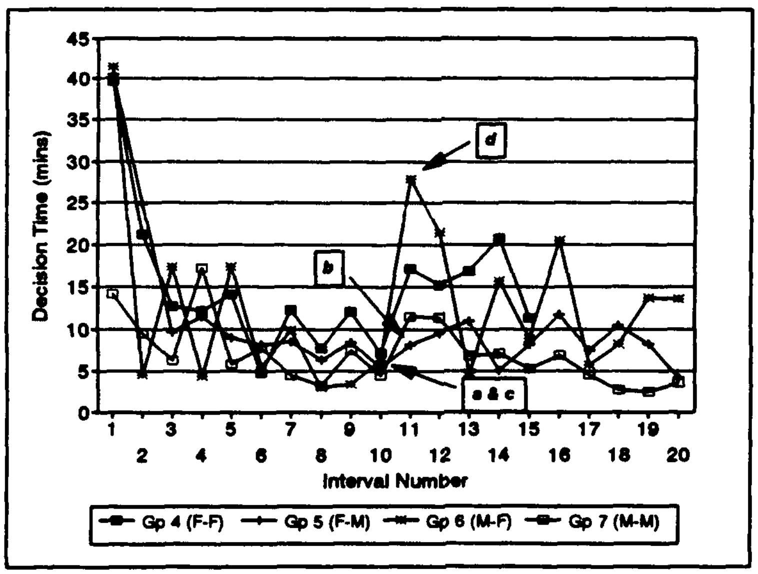


Figure 4.9. Transitions in Experimental Condition for Experiment 2.

dynamics probably also contributed to the differences experienced in the facilitated manual and facilitated GDSS groups. For example, note in Figure 4.6 Group 3, a facilitated GDSS group for both days, experienced the fastest decision speed of all groups in Experiment 1. Additionally, Group 3 experienced half the learning effect of the other GDSS groups, and was faster than Group 4, the facilitated manual control group, for all but three intervals. Probably due to structure effects, Group 3 was slower than Group 7, the unfacilitated manual group. It is not unknown whether Group 7 was faster than all other groups because of the demographic factors: they knew more group members than any other group. Group 7 had fewer years of experience in their career field, however. These factors may have led to fewer disagreements or even less thorough discussions which could have resulted in improved decision speed; however, the converse could also be true.

There were two interesting observations concerning other independent variables. The variable "Interval" was statistically significant for both experiments (p=.0001, $\alpha = .05$). Its negative parameter estimates indicated that as groups moved to later intervals, the time to complete these intervals decreased. Therefore, decision speed improved as the experiments progressed. Also, the variable "Day" with its negative parameter estimate was statistically significant for Experiment 1 ($p = .0024$, $\alpha = .05$), indicating that groups were faster on the second day. Both of these findings support the conclusion that some amount of learning effect was present in the group decision making processes.

4.3.3.2 Consensus. The results from the contingency table/Chi-Square tests showed that, proportionally, facilitated GDSS groups reached consensus less than facilitated manual groups, which experienced proportionally lower consensus than unfacilitated manual groups. It also took facilitated GDSS groups more votes proportionally to reach consensus than it did for facilitated manual groups. These observations suggest that structure does adversely affect consensus; however, group dynamics probably contributed to the significant differences in the outcomes of the facilitated GDSS and facilitated manual groups.

4.4 Results of the Statistical Analysis on Secondary Outcomes

4.4.1 User Responses Concerning Satisfaction and Perceptions.

4.4.1.1 Experiment 1, GDSS Effects. The research objective was to compare GDSS and non-GDSS groups to evaluate GDSS effects with respect to eight *dependent variables of interest*. These variables were stated in terms of:

- The user's satisfaction with the decision making process.
- The user's satisfaction with the results of the decision making process.
- The user's perception of task difficulty.
- The user's perception of the group's ability to stay task-focused.
- The user's perception of productivity in terms of time efficiency.
- The user's perception of productivity in terms of ability to reach consensus.
- The user's perception of the group's level of conflict.
- The user's perception of the level of process structure.

To measure the statistical significance of the experimental conditions with regard to the eight dependent variables of interest, two sets of tests were performed: Contingency table/Chi-Square and Sign tests.

The contingency table/Chi-Square tests were used to determine whether or not a significant difference existed between the distribution of responses for GDSS and FAC-MAN. These distributions were based on questionnaire responses across all GDSS and facilitated manual sessions for each day for every dependent variable of interest. Responses for each dependent variable of interest were classified into seven categories: from "1" meaning an extremely unfavorable response to "7" meaning an extremely favorable response. Chi-Square and Fisher's Exact tests were performed, and the hypotheses were:

H_o: There is No Difference between GDSS and FAC-MAN in Relationship to the *Dependent Variable of Interest.*

H_a: There is a Difference between GDSS and FAC-MAN in Relationship to the *Dependent Variable of Interest.*

Based on the Chi-Square and Fisher's Exact tests, the null hypothesis could not be rejected for any of the dependent variables of interest for either day (reference Tables 4.11 and 4.12). From these results, it was concluded that there was no difference between facilitated GDSS and facilitated manual with respect to:

- The user's satisfaction with the decision making process ($p = .288$ and $.614$, $\alpha = .05$).
- The user's satisfaction with the results of the decision making process ($p = 1.000$ and $.888$, $\alpha = .05$).
- The user's perception of task difficulty ($p = .972$ and $.907$, $\alpha = .05$).
- The user's perception of the group's ability to stay task-focused ($p = .811$ and $.799$, $\alpha = .05$).
- The user's perception of productivity in terms of time efficiency ($p = .097$ and $.890$, $\alpha = .05$).
- The user's perception of productivity in terms of ability to reach consensus ($p = .317$ and $.460$, $\alpha = .05$).
- The user's perception of the group's level of conflict ($p = .932$ and $.791$, $\alpha = .05$).
- The user's perception of the level of process structure ($p = 1.000$ and $.835$, $\alpha = .05$).

User responses recorded on the post-process questionnaires are summarized in tabular form in Appendix J. The contingency tables/Chi-Square test results are provided in Appendix K, and the Fisher's Exact test results are shown in Appendix L.

Table 4.11. Results: Experiment 1, Day 1 Participant Responses—Chi-Square Analysis.

VARIABLE	T VALUE	$\chi^2_{\alpha,\nu}$	χ^2 p VALUE	FISHER'S EXACT p VALUE	DECISION
Satisfied with Process	2.679	7.815	0.262	0.288	Fail to Reject H_o
Satisfied with Results	0.116	3.841	0.734	1.000	Fail to Reject H_o
Task Difficulty	2.457	11.070	0.783	0.972	Fail to Reject H_o
Stay Task-Focused	1.711	7.815	0.634	0.811	Fail to Reject H_o
Time Efficiency	8.923	12.592	0.178	0.097	Fail to Reject H_o
Reach Consensus	3.299	7.815	0.348	0.317	Fail to Reject H_o
Level of Conflict	2.649	11.070	0.754	0.932	Fail to Reject H_o
Level of Structure	0.446	5.991	0.800	1.000	Fail to Reject H_o

Table 4.12. Results: Experiment 1, Day 2 Participant Responses—Chi-Square Analysis.

VARIABLE	T VALUE	$\chi^2_{\alpha,\nu}$	χ^2 p VALUE	FISHER'S EXACT p VALUE	DECISION
Satisfied with Process	3.889	9.488	0.421	0.614	Fail to Reject H_o
Satisfied with Results	1.894	7.815	0.595	0.888	Fail to Reject H_o
Task Difficulty	2.257	11.070	0.813	0.907	Fail to Reject H_o
Stay Task-Focused	0.926	5.991	0.629	0.799	Fail to Reject H_o
Time Efficiency	1.667	7.815	0.644	0.890	Fail to Reject H_o
Reach Consensus	1.930	5.991	0.381	0.460	Fail to Reject H_o
Level of Conflict	3.914	11.070	0.562	0.791	Fail to Reject H_o
Level of Structure	0.705	5.991	0.703	0.835	Fail to Reject H_o

The Sign test was used to determine if the GDSS treatment yielded higher responses for each dependent variable of interest than FAC-MAN for those groups which experienced both experimental conditions over the two days (i.e., cross-over Groups 1 and 2). The Sign test compared the response levels (i.e., 1–7) by participant for both an objective test and a subjective test. The objective test compared an individual's responses for an experimental condition experienced and reported on day 1 to the individual's responses for an alternate experimental condition experienced and reported on day 2. The subjective test, however, was based on the individual's direct comparison between the two experimental conditions. The hypotheses for both the objective and subjective tests were:

$H_o : p(+) \leq p(-)$ or GDSS $\leq$ FAC-MAN for the *Dependent Variable of Interest.*

$H_a : p(+) > p(-)$ or GDSS $>$ FAC-MAN for the *Dependent Variable of Interest.*

Based on the Sign tests for the objective tests, the null hypothesis could not be rejected for any dependent variable of interest. It was concluded that facilitated GDSS groups did not experience higher levels of response for each of the dependent variables of interest (reference the p values in Table 4.13, $\alpha = .05$). Sign test calculations are provided in Appendix M.

Based on the Sign tests for the subjective tests, the null hypothesis was rejected for task difficulty ($p = .0156$, $\alpha = .05$) as shown in Table 4.13; however, this result conflicts with that from the objective test. It was concluded that the facilitated GDSS process was perceived as being more difficult, but the results are conflicting.

Table 4.13. Results: Experiment 1, Participant Responses—Sign Test Analysis.

VARIABLE	OBJECTIVE p VALUE	DECISION	SUBJECTIVE p VALUE	DECISION
Satisfied with Process	0.9680	Fail to Reject H_o	0.8750	Fail to Reject H_o
Satisfied with Results	0.6875	Fail to Reject H_o	0.8906	Fail to Reject H_o
Task Difficulty	0.0898	Fail to Reject H_o	0.0156	Reject H_o
Stay Task-Focused	0.9844	Fail to Reject H_o	0.1250	Fail to Reject H_o
Time Efficiency	0.9844	Fail to Reject H_o	0.9375	Fail to Reject H_o
Reach Consensus	0.6875	Fail to Reject H_o	0.6875	Fail to Reject H_o
Level of Conflict	0.3437	Fail to Reject H_o	0.1250	Fail to Reject H_o
Level of Structure	0.2266	Fail to Reject H_o	0.5000	Fail to Reject H_o

4.4.1.2 Experiment 2, Structure Effects. The research objective was to compare facilitated manual (FAC-MAN) and unfacilitated manual groups to evaluate structure effects with respect to eight dependent variables of interest. These variables were stated in terms of:

- The user's satisfaction with the decision making process.
- The user's satisfaction with the results of the decision making process.
- The user's perception of task difficulty.
- The user's perception of the group's ability to stay task-focused.
- The user's perception of productivity in terms of time efficiency.
- The user's perception of productivity in terms of ability to reach consensus.
- The user's perception of the group's level of conflict.
- The user's perception of the level of process structure.

To measure statistical significance of the experimental conditions with regard to the eight dependent variables of interest, two sets of tests were performed. Again, contingency table/Chi-Square tests were used to determine whether or not a significant difference existed between the distribution of responses for FAC-MAN and Manual. These distributions were based on questionnaire responses across all facilitated manual and unfacilitated manual sessions for each day for

every dependent variable of interest. Responses for each dependent variable of interest were classified into seven categories: from "1" meaning an extremely unfavorable response to "7" meaning an extremely favorable response. Chi-Square and Fisher's Exact tests were performed, and the hypotheses were:

H_o: There is No Difference between FAC-MAN and Manual in Relationship to the *Dependent Variable of Interest.*

H_a: There is a Difference between FAC-MAN and Manual in Relationship to the *Dependent Variable of Interest.*

Based on the Chi-Square and Fisher's Exact tests, the null hypothesis could not be rejected for any of the dependent variables of interest for either day (reference Tables 4.14 and 4.15). From these results, it was concluded that there was no difference between facilitated manual and unfacilitated manual groups with respect to:

- The user's satisfaction with the decision making process ($p = .659$ and $.654$, $\alpha = .05$).
- The user's satisfaction with the results of the decision making process ($p = .111$ and $.884$, $\alpha = .05$).
- The user's perception of task difficulty ($p = .146$ and $.926$, $\alpha = .05$).
- The user's perception of the group's ability to stay task-focused ($p = .829$ and $.799$, $\alpha = .05$).
- The user's perception of productivity in terms of time efficiency ($p = .807$ and $.881$, $\alpha = .05$).
- The user's perception of productivity in terms of ability to reach consensus ($p = .659$ and 1.000, $\alpha = .05$).
- The user's perception of the group's level of conflict ($p = .874$ and $.842$, $\alpha = .05$).
- The user's perception of the level of process structure ($p = .580$ and $.333$, $\alpha = .05$).

User responses recorded on the post-process questionnaires are summarized in tabular form in Appendix J. The contingency tables/Chi-Square test results are provided in Appendix K, and the Fisher's Exact test results are shown in Appendix L.

Table 4.14. Results: Experiment 2, Day 1 Participant Responses—Chi-Square Analysis.

VARIABLE	T VALUE	$\chi^2_{\alpha,\nu}$	χ^2 p VALUE	FISHER'S EXACT p VALUE	DECISION
Satisfied with Process	0.529	3.841	0.467	0.659	Fail to Reject H_o
Satisfied with Results	3.232	3.841	0.072	0.111	Fail to Reject H_o
Task Difficulty	7.917	11.070	0.161	0.146	Fail to Reject H_o
Stay Task-Focused	0.558	5.991	0.757	0.829	Fail to Reject H_o
Time Efficiency	1.190	5.991	0.551	0.807	Fail to Reject H_o
Reach Consensus	0.529	3.841	0.467	0.659	Fail to Reject H_o
Level of Conflict	3.413	11.070	0.637	0.874	Fail to Reject H_o
Level of Structure	1.650	5.991	0.438	0.580	Fail to Reject H_o

Table 4.15. Results: Experiment 2, Day 2 Participant Responses—Chi-Square Analysis.

VARIABLE	T VALUE	$\chi^2_{\alpha,\nu}$	χ^2 p VALUE	FISHER'S EXACT p VALUE	DECISION
Satisfied with Process	2.778	7.815	0.427	0.654	Fail to Reject H_o
Satisfied with Results	2.083	7.815	0.555	0.884	Fail to Reject H_o
Task Difficulty	2.753	11.070	0.738	0.926	Fail to Reject H_o
Stay Task-Focused	0.926	5.991	0.629	0.799	Fail to Reject H_o
Time Efficiency	1.797	7.815	0.616	0.881	Fail to Reject H_o
Reach Consensus	0.926	5.991	0.629	1.000	Fail to Reject H_o
Level of Conflict	2.525	9.488	0.640	0.842	Fail to Reject H_o
Level of Structure	1.852	5.991	0.396	0.333	Fail to Reject H_o

The Sign test was used to determine if the FAC-MAN treatment yielded higher responses for each dependent variable of interest than the Manual experimental condition for those groups which experienced both experimental conditions over the two days (i.e., cross-over Groups 5 and 6). The Sign test compared the response levels (i.e., 1–7) by participant for both an objective test and a subjective test. The objective test compared the two responses given by each individual for every question (dependent variable) from one experimental condition to the next. The subjective test, however, was based on the individual's own personal assessment of each dependent variable, making a comparison between the two experimental conditions at the same time (i.e., after completion of both experimental conditions). The hypotheses for both the objective and subjective tests were:

$H_o : p(+) \leq p(-)$ or FAC-MAN $\leq$ Manual for the *Dependent Variable of Interest.*

$H_a : p(+) > p(-)$ or FAC-MAN $>$ Manual for the *Dependent Variable of Interest.*

Based on the Sign tests which evaluated the objective tests, the null hypothesis was rejected for task difficulty (p = .0000, α = .05) and level of structure (p=.0000, α = .05) as shown in Table 4.16; however, neither of these null hypotheses was rejected under the subjective test. It was concluded that the facilitated manual process was perceived as being more difficult and more structured, but the results are conflicting. Sign test calculations are provided in Appendix M.

Based on the Sign tests for the subjective tests, the null hypothesis was rejected for level of conflict (p = .0000, α = .05) as shown in Table 4.16; however, the null hypothesis for this dependent variable was not rejected under the objective test. It was concluded that the facilitated manual process was perceived as causing greater conflict, but the results are conflicting.

4.4.2 Discussion. Even though some of the contingency tables were sparse, it was interesting to note that every decision concerning rejection of the null hypothesis (at α = .05) for each research objective was consistent between Fisher's Exact test and the Chi-Square test.

Table 4.16. Results: Experiment 2, Participant Responses—Sign Test Analysis.

VARIABLE	OBJECTIVE p VALUE	DECISION	SUBJECTIVE p VALUE	DECISION
Satisfied with Process	0.8125	Fail to Reject H_o	0.8125	Fail to Reject H_o
Satisfied with Results	0.9375	Fail to Reject H_o	0.9375	Fail to Reject H_o
Task Difficulty	0.0000	Reject H_o	0.2500	Fail to Reject H_o
Stay Task-Focused	0.5000	Fail to Reject H_o	0.9375	Fail to Reject H_o
Time Efficiency	0.8750	Fail to Reject H_o	0.9844	Fail to Reject H_o
Reach Consensus	0.8906	Fail to Reject H_o	0.9844	Fail to Reject H_o
Level of Conflict	0.9687	Fail to Reject H_o	0.0000	Reject H_o
Level of Structure	0.0000	Reject H_o	0.1875	Fail to Reject H_o

When all groups were considered for both experiments, there were no statistically significant differences between experimental conditions with respect to the user responses. However, the results from evaluating the cross-over groups indicated that there were some differences. It has already been shown in the Sign tests comparing these cross-over groups that the objective and subjective tests reached conflicting conclusions for a few of the dependent variables of interest. The conclusions reached for one dependent variable in Experiment 1 and three dependent variables in Experiment 2 were contradictory. As a tertiary objective in this study, the reliability of the questionnaire as an adequate measuring device was tested also using the Sign test. Here a comparison was made between the objective and subjective results, question by question, for the responses given by the cross-over groups for both experiments. The hypotheses for these comparisons were:

$H_o : p(+) \leq p(-)$ or Number of Times Objective and Subjective Results Agree $\leq$ Number of Times Objective and Subjective Results Disagree.

$H_a : p(+) > p(-)$ or Number of Times Objective and Subjective Results Agree $>$ Number of Times Objective and Subjective Results Disagree.

Based on the results from Experiment 1 (reference Table 4.17), only two comparisons resulted in the null hypothesis being rejected: satisfaction with the process (p = .0107, α = .10) and productivity in terms of time efficiency (p =.0547, α = .10). It was, therefore, concluded that only the results for these two questions in the Experiment 1 cross-over groups were highly reliable. The Sign test calculations are provided in Appendix M.

Based on the results from Experiment 2 (reference Table 4.18), four out of the eight comparisons resulted in the null hypothesis being rejected: satisfaction with the process (p = .0107, α = .10), satisfaction with the results (p = .0107, α = .10), time efficiency (p =.0547, α = .10), and level of structure (p = .0547, α = .10). Although level of structure had conflicting objective and subjective Sign test results (at α = .05), this question was considered highly reliable at α = .10. It

Table 4.17. Results: Experiment 1, Questionnaire Reliability—Sign Test Analysis.

VARIABLE	RELIABILITY p VALUE ($\alpha = .10$)	DECISION
Satisfied with Process	0.0107	Reject H_O
Satisfied with Results	0.6230	Fail to Reject H_O
Task Difficulty	0.6230	Fail to Reject H_O
Stay Task-Focused	0.8281	Fail to Reject H_O
Time Efficiency	0.0547	Reject H_O
Reach Consensus	0.1719	Fail to Reject H_O
Level of Conflict	0.6230	Fail to Reject H_O
Level of Structure	0.8281	Fail to Reject H_O

was concluded that only the results for these four questions (50%) in the Experiment 2 cross-over groups were highly reliable.

Table 4.18. Results: Experiment 2, Questionnaire Reliability—Sign Test Analysis.

VARIABLE	RELIABILITY p VALUE ($\alpha = .10$)	DECISION
Satisfied with Process	0.0107	Reject H_O
Satisfied with Results	0.0107	Reject H_O
Task Difficulty	0.1719	Fail to Reject H_O
Stay Task-Focused	0.1719	Fail to Reject H_O
Time Efficiency	0.0547	Reject H_O
Reach Consensus	0.1719	Fail to Reject H_O
Level of Conflict	0.9453	Fail to Reject H_O
Level of Structure	0.0547	Reject H_O

4.5 Noteworthy Facilitator Comments

All facilitator comments provided on the data collection forms and clarified during follow-up interviews are provided in Appendix N. Several noteworthy comments are provided below.

- Five of the six facilitated groups (GDSS and FAC-MAN) complained that the environmental tasks were poorly defined. The facilitators for a couple of groups noted that several participants required clarification of the training levels being considered. These comments were also voiced during the last large group session on Day 2. Since these definitions were provided by the sponsoring organizations, any related variability could not be controlled by the researcher. Although confusion over these items obviously added time to the decision making process (i.e., increased decision time) and potentially affected the voting process (i.e., lower

consensus), it is questionable whether they confounded the study's results concerning the performance outcomes, since all groups faced the same conditions. However, they may have confounded the results of the participants' responses on the post-process questionnaires. To be specific, while some participants may have made a distinction between the specific decision making process (i.e., the treatment) versus the confusion over the quality of the information provided by the sponsors, others may not have.

- One facilitator made the comment that the use of a GDSS was a physical barrier to effective communications. He noted that one member on two different occasions actually stood up in order to get his point across to the other group members.

- The two GDSS facilitators noted that using *GroupSystems* allowed the groups to refer to previously cast votes to ensure consistency in the needed environmental training levels across similar career fields. Several of the non-GDSS facilitators voiced the need to refer to previous votes. There was a clear advantage in using GDSS to recall previously accomplished work.

- Some groups did not have adequate representation for some career fields. Either the assigned representatives were not true experts in those areas or there was actually no true representative for a specific career field assigned to the group. This issue may have increased the decision making process for some groups, while slowing others down. No conclusion is made concerning the effect on the study's results. Again, this area could not be controlled by the researcher, since attendance at the conference and participant assignments to groups were handled by the sponsors.

- The researcher and the facilitators noted that some groups worked well together while others did not. Group dynamics appeared to influence the process as much as the use of GDSS technology or facilitation. Specifically, Group 1 included two members who did not desire to be participants in the small group processes. One technographer noted that this group had "too many experts" each wanting to steer the decisions of the group. In contrast, Group 3 worked extremely well together. The facilitator for this group (both days) noted that he provided little facilitation in order to keep the group moving—they provided their own momentum. It was interesting to note these observations are consistent with the regression analysis which indicated that Group 3 was the fastest group in Experiment 1 (p=.0014, $\alpha = .05$).

4.6 Noteworthy Participant Comments

Overwhelmingly, the participants stated that the environmental tasks and training levels were poorly defined. Many identified that the representation of personnel for certain career fields was inadequate to properly assess the necessary training levels. Except for these areas, there was no consensus of opinions concerning any of the decision making processes. Participant comments are provided in Appendix O.

Some members preferred using the GDSS, while others preferred the facilitated manual process. For example, members of Groups 1, 2, and 3 (i.e., groups exposed to GDSS) made the following comments:

- "I liked the software and use of computers."
- "Good computer program. It enhanced our performance."
- "Due to use of the computer, [it was] easier to recall [my] own position and the group's overall position—helped focus."
- "[The] computer program shows other career field scores...it can influence your decision."
- "[GDSS was] grossly time-consuming...no flexibility."
- "Computer interferes with group communications."
- "Computer process work was too long."
- "For small groups, this [facilitated manual] system is preferred. Larger groups would benefit from computer software."

Facilitation techniques were also either praised as helping the process or discarded as unnecessary and hindering the process (Groups 1–6):

- "The [GDSS] facilitator helped by repeating the task several times with the type of worker keeping focus on the vote at hand."
- "The [GDSS] facilitator kept us focused and interacted when necessary to overcome conflicts."
- "Used cards (1–5) [the] first day—[I] liked that better than voice voting. Helped in reaching consensus."
- Preferred the first day's process [FAC-MAN over the Manual process]—a bit more time-consuming, but drives more individual effort prior to team effort/concentration."
- "Yesterday's session had a facilitator and more energetic discussions, but also seemed more stressful."
- "The method used today [FAC-MAN] caused more conflicts to arise and the process was less conducive to a positive result."
- "The ability to talk through conflict and reach consensus was hampered by the structure of the voting process. There was a lower level of interaction among group members today. The formal voting system didn't work as well."

Several of the participants' comments were repeated in the large group session; however, none were stated as the consensus of the whole group. One original comment, though, seemed to meet everyone's approval: the group size of five was perfect, providing the right amount of breadth of

experience and level of discussion. Several members voiced their dislike for GDSS or for a structured facilitated process, while others opposed both of these views.

V. Conclusion and Recommendations

5.1 Overview of the Study

The current research contributed to the study of Group Decision Support Systems in field experiments which involve organizational decision making: real managers making real world decisions. An independent research effort conducted by the Air Force Institute of Technology in cooperation with the Air Force Armstrong Laboratory evaluated the efficacy of using GDSS technology in an Air Force decision making environment.

The study involved middle management Air Force civilian and military personnel who met in small five-member groups in a face-to-face setting. These groups participated in a choice-task decision making process over a two-day period. Each group attempted to reach consensus on 200 decisions concerning environmental training levels for a total of approximately 30 Air Force professions.

In evaluating the success of GDSS in terms of efficiency and effectiveness, past laboratory studies have reached very contradictory conclusions. Recent field studies have proclaimed fairly impressive results; however, the methods used in these studies were without tight experimental control, and the comparisons made between GDSS and non-GDSS have yielded fairly subjective results.

The current research provided increased experimental control, but simultaneously allowed enough flexibility to perform operational decision making tasks. This study objectively compared facilitated GDSS, facilitated manual, and unfacilitated manual groups using a multi-methodological approach by evaluating both real-time observations of the group decision making process and post-process opinions of the participants.

The research evaluated two performance outcomes: the efficiency of GDSS in terms of decision speed and the effectiveness of GDSS in terms of consensus. The principle focus of this study was to determine if the outcomes obtained were the result of using a GDSS or of increased process structure. Consequently, two distinct experiments were conducted. The participants were observed in order to compare each group's decision speed for 20 distinct intervals and each group's consensus for each of the 200 decisions. Post-process questionnaires were administered to measure participant responses and compare groups with respect to eight secondary outcomes:

- The user's satisfaction with the decision making process.
- The user's satisfaction with the group's results.
- The user's perception of task difficulty.
- The user's perception of the group's ability to remain task-focused.

- The user's perception of the group's productivity in terms of time efficiency.
- The user's perception of the group's productivity in terms of the group's ability to reach consensus.
- The user's perception of the group's level of conflict.
- The user's perception of the level of process structure.

Several statistical tests were performed to determine which of the outcomes were statistically significant at $\alpha = .05$. Multiple regression analysis was used to evaluate Decision Speed. Contingency tables/Chi-Square tests were used to evaluate Consensus. Contingency tables/Chi-Square and Sign tests were used to evaluate participant's responses for the secondary outcomes. Finally, the Sign test was used to evaluate the reliability of the post-process questionnaire at $\alpha = .10$.

5.2 Significant Findings for the Performance Outcomes

5.2.1 Decision Speed.

5.2.1.1 Experiment 1: GDSS Effects There was a significant relationship between the facilitated GDSS process and decision speed ($p = .0096$, $\alpha = .05$). It took facilitated GDSS groups longer to complete the decision making tasks than facilitated manual groups.

5.2.1.2 Experiment 2: Structure Effects. There was a significant relationship between the facilitated manual process and decision speed ($p = .0265$, $\alpha = .05$). It took facilitated manual groups longer to complete the decision making tasks than unfacilitated manual groups.

5.2.2 Consensus.

5.2.2.1 Experiment 1: GDSS Effects. The level of consensus, in terms of the total number of tasks for which the groups reached consensus, between facilitated GDSS groups and facilitated manual groups was not the same ($p = .042$, $\alpha = .05$). The level of consensus in facilitated GDSS groups was proportionally lower than the level of consensus in facilitated manual groups.

The ability to reach consensus between facilitated GDSS and facilitated manual groups was not the same ($p = .0006$, $\alpha = .05$). Proportionally, facilitated manual groups reached consensus in fewer votes than did facilitated GDSS groups.

5.2.2.2 Experiment 2: Structure Effects. The level of consensus between facilitated manual and unfacilitated manual groups was not the same ($p = .0006$, $\alpha = .05$). The level of

consensus in facilitated manual groups was proportionally lower than the level of consensus in unfacilitated manual groups.

5.2.3 Concluding Remarks Concerning Performance Outcomes. It was noted that the structured processes exhibited greater initial learning curves for one or two intervals whenever groups transitioned from a less structured process to a more structured process. Specifically, facilitated GDSS groups experienced a large learning curve, facilitated manual groups experienced a medium learning curve, and unfacilitated manual groups experienced a small learning curve. Groups transitioning in the opposite direction did not experience such an increase.

Facilitated GDSS groups experienced slower decision speeds than facilitated manual groups which, in turn, experienced slower decision speeds than that of unfacilitated manual groups. From Experiment 2 there was a clear indication that process structure did adversely affect decision speed; however, group dynamics probably contributed to the differences experienced in the facilitated manual and facilitated GDSS groups in Experiment 1. Based on the facilitator and participant comments, groups which seemed to work well together tended to produce better results. Finally, decision speed generally improved for all groups as time progressed. This observation supported the theory of the learning curve effect.

Proportionally, facilitated GDSS groups reached consensus less frequently than did facilitated manual groups which, in turn, reached consensus less frequently (i.e., proportionally) than did unfacilitated manual groups. It also took facilitated GDSS groups more votes proportionally to reach consensus than it did for facilitated manual groups. These observations suggest that structure adversely affects the rate at which groups achieve consensus; however, group dynamics probably contributed to the significant differences in the outcomes of the facilitated GDSS and facilitated manual groups.

5.3 Significant Findings for the Secondary Outcomes

5.3.1 Experiment 1, Groups 1-4: GDSS Effects. Considering all Experiment 1 groups for both days, there was no difference between facilitated GDSS and facilitated manual groups with respect to the following eight secondary outcomes:

- The user's satisfaction with the decision making process ($p = .288$ and $.614$, $\alpha = .05$).
- The user's satisfaction with the results of the decision making process ($p = 1.000$ and $.888$, $\alpha = .05$).
- The user's perception of task difficulty ($p = .972$ and $.907$, $\alpha = .05$).
- The user's perception of the group's ability to stay task-focused ($p = .811$ and $.799$, $\alpha = .05$).

- The user's perception of productivity in terms of time efficiency ($p = .097$ and $.890$, $\alpha = .05$).
- The user's perception of productivity in terms of ability to reach consensus ($p = .317$ and $.460$, $\alpha = .05$).
- The user's perception of the group's level of conflict ($p = .932$ and $.791$, $\alpha = .05$).
- The user's perception of the level of process structure ($p = 1.000$ and $.835$, $\alpha = .05$).

5.3.2 Experiment 1, Groups 1 & 2: GDSS Effects. Specifically evaluating only the cross-over groups, facilitated GDSS groups did not experience higher levels of response for any of the eight secondary outcomes for the objective tests which compared participant's responses between experimental conditions. For the subjective tests which required the participant to make a comparison, facilitated GDSS groups perceived the task as being more difficult ($p = .0156$, $\alpha = .05$).

5.3.3 Experiment 2, Groups 4-7: Structure Effects. Considering all Experiment 2 groups for both days, there was no difference between facilitated manual and unfacilitated manual groups with respect to the following eight secondary outcomes:

- The user's satisfaction with the decision making process ($p = .659$ and $.654$, $\alpha = .05$).
- The user's satisfaction with the results of the decision making process ($p = .111$ and $.884$, $\alpha = .05$).
- The user's perception of task difficulty ($p = .146$ and $.926$, $\alpha = .05$).
- The user's perception of the group's ability to stay task-focused ($p = .829$ and $.799$, $\alpha = .05$).
- The user's perception of productivity in terms of time efficiency ($p = .807$ and $.881$, $\alpha = .05$).
- The user's perception of productivity in terms of ability to reach consensus ($p = .659$ and 1.000, $\alpha = .05$).
- The user's perception of the group's level of conflict ($p = .874$ and $.842$, $\alpha = .05$).
- The user's perception of the level of process structure ($p = .580$ and $.333$, $\alpha = .05$).

5.3.4 Experiment 2, Groups 5 & 6: Structure Effects. Specifically evaluating only the cross-over groups, facilitated manual groups perceived tasks to be more difficult ($p = .0000$, $\alpha = .05$) and more structured ($p=.0000$, $\alpha = .05$) for the objective tests which compared participant's responses between experimental conditions. For the subjective tests which required the participant to make a comparison, facilitated manual groups perceived a higher level of group conflict than the unfacilitated manual groups ($p = .0000$, $\alpha = .05$).

5.3.5 Concluding Remarks Concerning Secondary Outcomes. Whenever all groups in Experiment 1 were taken into consideration, none of the secondary outcomes were considered significant. Considering only the cross-over groups, however, facilitated GDSS groups perceived the task to be more difficult, but the objective and subjective results conflict. It was concluded that facilitated GDSS participants perceived the process as being more difficult.

The same situation occurred in Experiment 2. None of the secondary outcomes were considered significant when all groups were compared; however, the cross-over groups perceived a higher level of task difficulty, a higher level of structure, and a higher level of conflict for the facilitated manual process. Again, the objective and subjective test results conflict. It was concluded that facilitated manual participants perceived higher levels of task difficulty, structure, and conflict.

5.3.6 Questionnaire Reliability. As was shown in the objective and subjective tests of the secondary outcomes, the conclusions reached for one dependent variable in Experiment 1 and three dependent variables in Experiment 2 were contradictory. A comparison of the objective and subjective results for Experiment 1 indicated that only two of the eight secondary outcomes were highly reliable: user satisfaction with the process ($p = .0107$, $\alpha = .10$) and productivity in terms of time efficiency ($p =.0547$, $\alpha = .10$). A similar comparison for Experiment 2 indicated that only four of the eight secondary outcomes were highly reliable: user satisfaction with the process ($p = .0107$, $\alpha = .10$), user satisfaction with the results ($p = .0107$, $\alpha = .10$), user perception of time efficiency ($p =.0547$, $\alpha = .10$), and user perception of the level of structure ($p = .0547$, $\alpha = .10$).

5.4 Conclusions Based on Facilitator and Participant Comments

Five of the six facilitated groups stated that the environmental tasks were not adequately defined. Also, several participants in various groups stated that there was not adequate representation for some career fields in their groups. Since these comments were randomly scattered throughout the groups, any adverse effects should have been experienced across most all groups. However, no precise conclusion could be made concerning the effect on the study's results.

Several participants felt that use of a GDSS was time-consuming, and that it physically interfered with effective group communications. On the contrary, other members praised the GDSS, because it provided the capability to recall previously cast votes which helped groups maintain consistency in the assignment of environmental training levels for similar career fields. Support and non-support of the GDSS seemed to be group dependent—again an indication of the contributing factors associated with group dynamics.

The comments concerning facilitation were also mixed. Some members claimed that facilitation helped keep the group focused, but it required a greater level of concentration. Some members simply preferred the unfacilitated manual method.

One final comment made during the large group session appeared to meet consensus across all the groups. They stated that the group size of five members was ideal, providing the right amount of breadth of experience and level of discussion.

5.5 *Conclusions Applicable to Previous GDSS Field Studies*

Although the results stemming from the earlier laboratory studies have been largely contradictory, the field studies have resulted in several fairly consistent findings with respect to the success or failure of the application of GDSS (or GSS) in real world environments. Several general findings are repeated here for comparison purposes.

- GDSS "technology used in the field appears to improve performance, efficiency, and user satisfaction" (6:73), (22:219). This study contradicts these findings, since performance, in terms of consensus, and efficiency were shown to be lower for facilitated GDSS groups than both facilitated manual and unfacilitated manual groups. This study found no difference in the level of satisfaction for any of the three experimental conditions.
- "The effects of GSS appear to depend on a variety of factors: the technology itself, the group, and the task" (6:73). This study essentially supports these findings, especially since group dynamics appeared to be as much a contributing factor to the results as the technology, specifically with respect to the secondary outcomes.
- "We are less convinced that GSS technology can help groups facing a choice task, where the objective is to choose an alternative(s) from a pre-specified set. For these types of tasks, GSS technology may help, but the evidence is not as clear as that for generation tasks" (6:74). This study clearly confirms this finding, although group dynamics was a contributing factor to the results.
- "There is better fit between GSS and complex tasks" (6:74). This study neither confirms nor contradicts this finding with respect to complex tasks; however, the study does confirm that GDSS use did not result in improved performance for relatively simple tasks such as choice-type decision making.
- "Efficiency considerations of GDSS become increasingly apparent as group size increases. It is difficult to demonstrate that GDSS promotes group efficiency for small groups (e.g., 3 to 5)...Group effectiveness is enhanced as group size increases...the effectiveness of GDSS becomes apparent in facilitating large numbers of issues associated with a complex question" (41:124). Generally speaking, this study confirms that the efficiency and effectiveness for

small groups performing a relatively simple choice-task using GDSS were not better than the efficiency and effectiveness of non-GDSS groups.

- "The value of process structure for larger groups has been demonstrated in numerous field studies...process structure is useful for large groups facing complex tasks, but may not have much effect on small groups or groups performing well-defined tasks" (31:138). The results of this study contradict these findings. Process structure did have an effect on the small groups in this study; however, the effect negatively impacted the performance outcomes.

5.6 Recommendations

It is certainly too early in the development and study of GDSS for the Air Force to make significant investments in this technology. Armstrong Laboratory and the Air Force Institute of Technology should continue the partnership to conduct objective field research. This research is needed to adequately determine which types of Air Force groups and what types of Air Force decision making tasks are best suited for GDSS application. Additionally, further study is warranted to identify decision quality variables which constitute appropriate measures of effectiveness for a variety of Air Force decision making tasks. Based on the results of this study and the findings from other field studies, the following additional research is recommended:

- Conduct a factorial experiment in a similar choice-type decision making process to study two factors: group size (i.e., groups of 5 versus 10 members) and technology (i.e., GDSS versus non-GDSS). Such a study would attempt to validate the finding that large groups benefit from GDSS use more than small groups, in addition to studying the presence or absence of GDSS technology.
- Conduct a study similar to the current study, except increase the complexity of the task by having members generate and rank order alternatives and then choose a course of action. Such a study would attempt to validate the finding that more complex tasks benefit from GDSS use.
- Conduct a longitudinal study to determine specific functional areas and types of tasks that may best benefit from use of GDSS. Such a study should place particular attention on evaluating the effects of group dynamics to the outcomes of the decision making processes.
- Eventually, conduct a factorial experiment to study two factors: group size (i.e., 5 or 10 members per group) and group proximity (i.e., face-to-face versus dispersed). This is one area where Air Force decision makers may benefit fiscally, should the technology produce positive results and be accepted by Air Force members.

- Conduct a longitudinal study to develop and validate a reliable survey instrument to accurately measure the perceptions of GDSS users. It has already been shown that existing instruments produce somewhat unreliable results. Such instruments will be necessary to capture users' acceptance of the technology prior to fielding operational systems in the work place.

Comments from this study identified a genuine need to reduce the physical obstruction of the GDSS hardware. These limitations adversely affected communications between group members. Recommend that Armstrong Laboratory invest in computer consoles which recess the computer and its monitor out of the direct line-of-sight between group members. This will preclude the technology from directly interfering with effective group communications. Also, recommend that Armstrong Laboratory acquire an audio recording capability so that group conversations may be captured and later analyzed. This capability will be essential towards evaluating the group dynamics aspects of GDSS research.

Appendix A. Post-Process Questionnaire: Day One

Post-Process Questionnaire

Group/Individual Number: __________ Date: __________

Please answer the following questions using the scale provided with each respective question.
Please circle only ONE number which best describes your opinion for each particular question.

1. How satisfied are you with the RESULTS your group produced?

Extremely Dissatisfied	Moderately Dissatisfied	Barely Dissatisfied	Borderline	Barely Satisfied	Moderately Satisfied	Extremely Satisfied
1	2	3	4	5	6	7

2. Taking all things into consideration, how DIFFICULT was this group task?

Extremely Easy	Moderately Easy	Barely Easy	Borderline	Barely Difficult	Moderately Difficult	Extremely Difficult
1	2	3	4	5	6	7

3. To what degree was your group able to STAY FOCUSED on completing the task?

Extremely Distracted	Moderately Distracted	Barely Distracted	Borderline	Barely Focused	Moderately Focused	Extremely Focused
1	2	3	4	5	6	7

4. In terms of TIME EFFICIENCY, how productive was your group?

Extremely Unproductive	Moderately Unproductive	Barely Unproductive	Borderline	Barely Productive	Moderately Productive	Extremely Productive
1	2	3	4	5	6	7

5. In terms of agreement/disagreement, what level of CONFLICT did your group experience?

Extremely Disagreeable	Moderately Disagreeable	Barely Disagreeable	Borderline	Barely Agreeable	Moderately Agreeable	Extremely Agreeable
1	2	3	4	5	6	7

6. In terms of ABILITY TO REACH CONSENSUS, how productive was your group?

Extremely Unproductive	Moderately Unproductive	Barely Unproductive	Borderline	Barely Productive	Moderately Productive	Extremely Productive
1	2	3	4	5	6	7

(continued on next page)

Post-Process Questionnaire

7. Overall, how satisfied are you with the GROUP PROCESS you just completed?

Extremely Dissatisfied	Moderately Dissatisfied	Barely Dissatisfied	Borderline	Barely Satisfied	Moderately Satisfied	Extremely Satisfied
1	2	3	4	5	6	7

8. Based on your perceptions, how STRUCTURED was this group process?

Extremely Unstructured	Moderately Unstructured	Barely Unstructured	Borderline	Barely Structured	Moderately Structured	Extremely Structured
1	2	3	4	5	6	7

9. Please provide any comments concerning POSITIVE aspects of your group's process or experience.

10. Please provide any comments concerning NEGATIVE aspects of your group's process or experience.

(continued on next page)

Post-Process Questionnaire

11. Please provide any additional comments below.

Appendix B. Post-Process Questionnaire: Day Two

Post-Process Questionnaire

Group/Individual Number: __________ **Date:** __________

Please answer the following questions using the scale provided with each respective question. Please circle only ONE number which best describes your opinion for each particular question.

1. How satisfied are you with the RESULTS your group produced?

Extremely Dissatisfied	Moderately Dissatisfied	Barely Dissatisfied	Borderline	Barely Satisfied	Moderately Satisfied	Extremely Satisfied
1	2	3	4	5	6	7

2. Taking all things into consideration, how DIFFICULT was this group task?

Extremely Easy	Moderately Easy	Barely Easy	Borderline	Barely Difficult	Moderately Difficult	Extremely Difficult
1	2	3	4	5	6	7

3. To what degree was your group able to STAY FOCUSED on completing the task?

Extremely Distracted	Moderately Distracted	Barely Distracted	Borderline	Barely Focused	Moderately Focused	Extremely Focused
1	2	3	4	5	6	7

4. In terms of TIME EFFICIENCY, how productive was your group?

Extremely Unproductive	Moderately Unproductive	Barely Unproductive	Borderline	Barely Productive	Moderately Productive	Extremely Productive
1	2	3	4	5	6	7

5. In terms of agreement/disagreement, what level of CONFLICT did your group experience?

Extremely Disagreeable	Moderately Disagreeable	Barely Disagreeable	Borderline	Barely Agreeable	Moderately Agreeable	Extremely Agreeable
1	2	3	4	5	6	7

6. In terms of ABILITY TO REACH CONSENSUS, how productive was your group?

Extremely Unproductive	Moderately Unproductive	Barely Unproductive	Borderline	Barely Productive	Moderately Productive	Extremely Productive
1	2	3	4	5	6	7

(continued on next page)

Post-Process Questionnaire

7. Overall, how satisfied are you with the GROUP PROCESS you just completed?

Extremely Dissatisfied	Moderately Dissatisfied	Barely Dissatisfied	Borderline	Barely Satisfied	Moderately Satisfied	Extremely Satisfied
1	2	3	4	5	6	7

8. Based on your perceptions, how STRUCTURED was this group process?

Extremely Unstructured	Moderately Unstructured	Barely Unstructured	Borderline	Barely Structured	Moderately Structured	Extremely Structured
1	2	3	4	5	6	7

9. Comparing today's small group process with yesterday afternoon's small group process, how would you rate the following items:

	Higher Today	Unchanged	Higher Yesterday
a. Your level of satisfaction with the group's outcome?	☐	☐	☐
b. Your perception of the level of task difficulty?	☐	☐	☐
c. Your group's ability to remain focused on the task?	☐	☐	☐
d. Your group's overall productivity in terms of time efficiency?	☐	☐	☐
e. Your perception of the level of conflict within the group?	☐	☐	☐
f. Your group's overall productivity in terms of ability to reach consensus?	☐	☐	☐
g. Your level of satisfaction with the group process?	☐	☐	☐
h. Your perception of the level of group process structure?	☐	☐	☐

10. Please provide any comments concerning POSITIVE aspects of your group's process or experience.

(continued on next page)

Post-Process Questionnaire

11. Please provide any comments concerning NEGATIVE aspects of your group's process or experience.

12. Please provide specific reasons why you may have preferred one day's group process over the other day's (or any other comments you wish to make).

Appendix C. Participant Demographics: Pre-Process Questionnaire Results

INDIVIDUAL	RANK/ GRADE	AGE	GENDER	YEARS IN CAREER	YEARS IN OFFICE	COMPUTER AT WORK	COMPUTER AT HOME	COMPUTER TRAINING	EDUCATION LEVEL	COMFORT USING A COMPUTER	MEMBERS KNOWN
1-1	4	43	MALE	18	2	YES	YES	YES	5	7	6
1-2	3	44	MALE	10	17	YES	YES	YES	5	7	1
1-3	3	38	MALE	10	2	YES	YES	YES	6	7	4
1-4	3	47	MALE	2	1	YES	YES	YES	5	5	1
1-5	5	60	MALE	30	1	YES	NO	YES	6	6	2
Mean:	NA	46.0	1.0	15.4	4.6	1.0	0.8	1.0	NA	NA	1.6
Median:	3								5	7	
Mode:	3								5	7	
2-1	4	37	MALE	5	3	YES	YES	YES	4	6	0
2-2	4	56	MALE	30	0	YES	YES	YES	4	6	0
2-3	3	38	FEMALE	6	5	YES	YES	NO	3	4	0
2-4	4	57	MALE	24	9	NO	NO	YES	4	4	1
2-5	2	56	MALE	18	12	YES	YES	YES	5	7	1
Mean:	NA	48.4	0.8	16.6	6.2	0.8	0.8	0.8	NA	NA	0.4
Median:	4								4	6	
Mode:	4								4	4/6	
3-1		35	MALE	9	1	YES	NO	YES	5	4	1
3-2	1	40	MALE	22	4	YES	NO	YES	2	6	1
3-3	3	35	MALE	13	0	YES	YES	YES	5	7	0
3-4	3	37	MALE	5	2	YES	NO	YES	4	6	
3-5		34	MALE	3	0	NO	YES	NO	5	2	0
Mean:	NA	40.2	1.0	10.4	1.3	0.8	0.4	0.8	NA	NA	0.4
Median:	3								5	6	
Mode:	3								5	6	
4-1	3	48	MALE	20	1	YES	NO	YES	5	6	0
4-2	2	27	FEMALE	6	1	YES	NO	YES	3	7	2
4-3	3	29	MALE	3	3	YES	YES	YES	4	7	0
4-4	4	34	FEMALE	10	2	YES	NO	YES	6	7	1
4-5	3	54	MALE	28	9	YES	YES	YES	4	5	3
Mean:	NA	38.6	0.6	13.4	3.1	1.0	0.4	1.0	NA	NA	1.2
Median:	3								5	7	
Mode:	3								4	7	
5-1	2	51	MALE	7	7	NO	NO	NO	5	1	1
5-2	4	48	MALE	21	21	YES	NO	YES	4	6	0
5-3	2	34	MALE	11	2	YES	YES	NO	5	6	1
5-4		54	MALE	36	6	YES	NO	YES	3	6	2
5-5	4	39	MALE	9	2	YES	NO	YES	5	5	2
Mean:	NA	44.6	1.0	16.8	7.5	0.8	0.2	0.6	NA	NA	1.2
Median:	3								5	6	
Mode:	2/4								5	6	
6-1	5	44	MALE	26	0	YES	YES	YES	5	7	0
6-2	2	33	FEMALE	14	6	YES	YES	YES	4	6	0
6-3		37	FEMALE	10	5	YES	NO	NO	2	6	0
6-4		44	MALE	17	7	YES	YES	YES	6	7	0
6-5	2	32		5	1	YES	YES	YES	4	7	1
Mean:	NA	38.0	0.5	14.4	4.2	1.0	0.8	0.8	NA	NA	0.2
Median:	2								4	7	
Mode:	2								4	7	
7-1	3	44	FEMALE	5	1	YES	YES	YES	4	7	1
7-2	1	39		11	11	YES	YES	YES	2	7	2
7-3	5	46	FEMALE	12	1	YES	NO	NO	5	6	3
7-4	4	42	MALE	2	3	YES	YES	YES	6	7	1
7-5	3	36	MALE	9	5	YES	YES	YES	6	5	2
Mean:	NA	41.0	0.5	7.8	4.2	1.0	0.8	0.8	NA	NA	1.8
Median:	3								5	7	
Mode:	3								6	7	
POPULATION											
Mean:	NA	42.4	0.8	13.8	4.4	0.9	0.6	0.8	NA	NA	1.0
Median:	3								5	6	
Mode:	3								5	7	

LEGEND

Civilian Grade	Military Rank	Index
Below GS-11	Below Captain	1
GS-11/12	Captain	2
GS-13	Major	3
GS-14	Lt Colonel	4
GS-15	Colonel	5

Education Level	Index
High School Diploma	1
College Courses Taken	2
Undergraduate Degree	3
Graduate Courses Taken	4
Graduate Degree	5
PhD or MD	6

Comfort Level	Index
Extremely Uncomfortable	1
Moderately Uncomfortable	2
Barely Uncomfortable	3
Borderline	4
Barely Comfortable	5
Moderately Comfortable	6
Extremely Comfortable	7

Figure C.1. Pre-Process Questionnaire Results.

Appendix D. Data Correlation and Equations for Experiment 1

CORRELATION BETWEEN SI AND EM

INTERVAL 1 TO 10

Correlation Analysis

2 'VAR' Variables: SI EM

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
SI	10	14.3833	9.9233	143.8330	4.7500	39.5830
EM	10	13.2358	10.9805	132.3580	5.5000	40.4160

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 10

	SI	EM
SI	1.00000 0.0	0.96371 0.0001
EM	0.96371 0.0001	1.00000 0.0

Mathematica Equations for SI and EM during Intervals 1–10

Equation for SI:

$$y = 90.0082 - 73.3668x + 27.9537x^2 - 5.2469x^3 + 0.472959x^4 - 0.0162701x^5$$

Equation for EM:

$$y = 75.1361 - 44.4634x + 11.7412x^2 - 1.53825x^3 + 0.10042x^4 - 0.00264731x^5$$

Appendix E. Decision Speed Interval Data

Table E.1. Interval Times for Experiment 1, Groups 1 and 2

GROUP	DAY	INTERVAL	GDSS	FACILITATOR	TIME (mins)
1	1	1	YES	GR	32
1	1	2	YES	GR	40.67
1	1	3	YES	GR	16.58
1	1	4	YES	GR	30.25
1	1	5	YES	GR	16.33
1	1	6	YES	GR	
1	1	7	YES	GR	
1	1	8	YES	GR	
1	1	9	YES	GR	
1	1	10	YES	GR	
1	2	11	NO	SH	12.66
1	2	12	NO	SH	13.1
1	2	13	NO	SH	14.75
1	2	14	NO	SH	13.93
1	2	15	NO	SH	5.46
1	2	16	NO	SH	6.033
1	2	17	NO	SH	7.55
1	2	18	NO	SH	6.25
1	2	19	NO	SH	7.517
1	2	20	NO	SH	10.95
2	1	1	NO	SH	
2	1	2	NO	SH	
2	1	3	NO	SH	
2	1	4	NO	SH	
2	1	5	NO	SH	
2	1	6	NO	SH	21.35
2	1	7	NO	SH	9.667
2	1	8	NO	SH	8.333
2	1	9	NO	SH	6.667
2	1	10	NO	SH	3.566
2	2	11	YES	GR	41.917
2	2	12	YES	GR	16.833
2	2	13	YES	GR	10.333
2	2	14	YES	GR	13.667
2	2	15	YES	GR	13.583
2	2	16	YES	GR	
2	2	17	YES	GR	
2	2	18	YES	GR	
2	2	19	YES	GR	
2	2	20	YES	GR	

Table E.2. Interval Times for Experiment 1, Groups 3 and 4

GROUP	DAY	INTERVAL	GDSS	FACILITATOR	TIME (mins)
3	1	1	YES	TE	20.85
3	1	2	YES	TE	16.667
3	1	3	YES	TE	11.383
3	1	4	YES	TE	13.75
3	1	5	YES	TE	11.683
3	1	6	YES	TE	7.65
3	1	7	YES	TE	12.15
3	1	8	YES	TE	6.783
3	1	9	YES	TE	5.7
3	1	10	YES	TE	6.967
3	2	11	YES	TE	11.5
3	2	12	YES	TE	13.733
3	2	13	YES	TE	7.6
3	2	14	YES	TE	5.067
3	2	15	YES	TE	12.583
3	2	16	YES	TE	7.2
3	2	17	YES	TE	3.833
3	2	18	YES	TE	6.65
3	2	19	YES	TE	3.183
3	2	20	YES	TE	2.916
4	1	1	NO	SI	39.583
4	1	2	NO	SI	21.167
4	1	3	NO	SI	12.75
4	1	4	NO	SI	12.167
4	1	5	NO	SI	14.083
4	1	6	NO	SI	4.75
4	1	7	NO	SI	12.25
4	1	8	NO	SI	7.75
4	1	9	NO	SI	12.083
4	1	10	NO	SI	7.25
4	2	11	NO	EM	17.083
4	2	12	NO	EM	15.167
4	2	13	NO	EM	16.833
4	2	14	NO	EM	20.7
4	2	15	NO	EM	11.3
4	2	16	NO	EM	
4	2	17	NO	EM	
4	2	18	NO	EM	
4	2	19	NO	EM	
4	2	20	NO	EM	

Table E.3. Interval Times for Experiment 2, Groups 4 and 5

GROUP	DAY	INTERVAL	FACILITATED	FACILITATOR	TIME (mins)
4	1	1	YES	SI	39.583
4	1	2	YES	SI	21.167
4	1	3	YES	SI	12.75
4	1	4	YES	SI	12.167
4	1	5	YES	SI	14.083
4	1	6	YES	SI	4.75
4	1	7	YES	SI	12.25
4	1	8	YES	SI	7.75
4	1	9	YES	SI	12.083
4	1	10	YES	SI	7.25
4	2	11	YES	EM	17.083
4	2	12	YES	EM	15.167
4	2	13	YES	EM	16.833
4	2	14	YES	EM	20.7
4	2	15	YES	EM	11.3
4	2	16	YES	EM	
4	2	17	YES	EM	
4	2	18	YES	EM	
4	2	19	YES	EM	
4	2	20	YES	EM	
5	1	1	YES	EM	40.416
5	1	2	YES	EM	24.833
5	1	3	YES	EM	9.667
5	1	4	YES	EM	11.5
5	1	5	YES	EM	8.95
5	1	6	YES	EM	8.16
5	1	7	YES	EM	8.5
5	1	8	YES	EM	6.416
5	1	9	YES	EM	8.416
5	1	10	YES	EM	5.5
5	2	11	NO	NONE	8.083
5	2	12	NO	NONE	9.63
5	2	13	NO	NONE	10.933
5	2	14	NO	NONE	8.066
5	2	15	NO	NONE	8.2
5	2	16	NO	NONE	11.75
5	2	17	NO	NONE	7.45
5	2	18	NO	NONE	10.433
5	2	19	NO	NONE	8.217
5	2	20	NO	NONE	4.167

Table E.4. Interval Times for Experiment 2, Groups 6 and 7

GROUP	DAY	INTERVAL	FACILITATED	FACILITATOR	TIME (mins)
6	1	1	NO	NONE	41.5
6	1	2	NO	NONE	4.583
6	1	3	NO	NONE	17.417
6	1	4	NO	NONE	4.367
6	1	5	NO	NONE	17.383
6	1	6	NO	NONE	5.583
6	1	7	NO	NONE	9.917
6	1	8	NO	NONE	3
6	1	9	NO	NONE	3.33
6	1	10	NO	NONE	6.283
6	2	11	YES	SI	28
6	2	12	YES	SI	21.417
6	2	13	YES	SI	4.75
6	2	14	YES	SI	15.667
6	2	15	YES	SI	8.833
6	2	16	YES	SI	20.5
6	2	17	YES	SI	5.75
6	2	18	YES	SI	8.25
6	2	19	YES	SI	13.75
6	2	20	YES	SI	13.583
7	1	1	NO	NONE	14.233
7	1	2	NO	NONE	9.5
7	1	3	NO	NONE	6.333
7	1	4	NO	NONE	17.25
7	1	5	NO	NONE	5.833
7	1	6	NO	NONE	7.833
7	1	7	NO	NONE	4.417
7	1	8	NO	NONE	3.25
7	1	9	NO	NONE	7.5
7	1	10	NO	NONE	4.467
7	2	11	NO	NONE	11.5
7	2	12	NO	NONE	11.417
7	2	13	NO	NONE	6.833
7	2	14	NO	NONE	7.083
7	2	15	NO	NONE	5.25
7	2	16	NO	NONE	6.917
7	2	17	NO	NONE	4.583
7	2	18	NO	NONE	2.717
7	2	19	NO	NONE	2.45
7	2	20	NO	NONE	3.567

Appendix F. Regression Analysis Results for Decision Speed

EXPERIMENT 1: GDSS VERSUS FACILITATED-MANUAL
REGRESSION ANALYSIS USING INDICATOR VARIABLES

Model: MODEL1
Dependent Variable: TIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	2687.18974	447.86496	13.486	0.0001
Error	53	1760.08047	33.20907		
C Total	59	4447.27020			

Root MSE	5.76273	R-square	0.6042
Dep Mean	13.21183	Adj R-sq	0.5594
C.V.	43.61795		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	24.070314	2.16227846	11.132	0.0001
GROUP1	1	-0.418325	2.37244192	-0.176	0.8607
GROUP2	1	-2.044866	2.79508739	-0.732	0.4676
GROUP3	1	-10.976979	3.42756253	-3.203	0.0023
DAY	1	-4.388051	1.57141794	-2.792	0.0073
INTERVAL	1	-1.631407	0.29457261	-5.538	0.0001
FACILITY	1	7.465827	2.63585370	2.832	0.0065

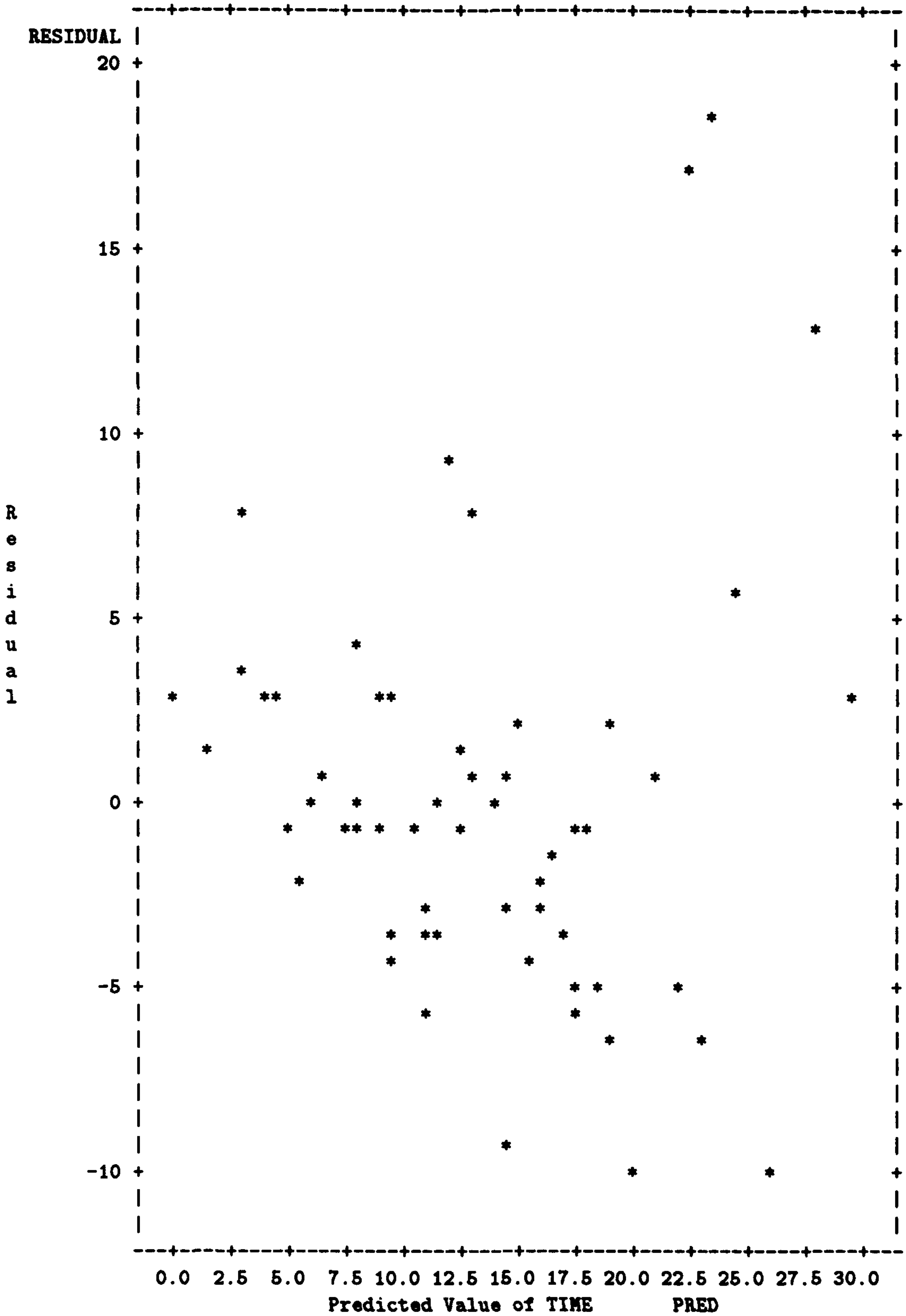
Variable	DF	Variance Inflation
INTERCEP	1	0.00000000
GROUP1	1	1.90672055
GROUP2	1	1.96043696
GROUP3	1	4.71685858
DAY	1	1.11536758
INTERVAL	1	1.26618320
FACILITY	1	3.13817538

Durbin-Watson D	1.933
(For Number of Obs.)	60
1st Order Autocorrelation	0.032

Obs	Dep Var TIME	Predict Value	Residual
1	32.0000	29.4864	2.5136
2	40.6700	27.8550	12.8150
3	16.5800	26.2236	-9.6436
4	30.2500	24.5922	5.6578
5	16.3300	22.9608	-6.6308
6	12.6600	17.6325	-4.9725
7	13.1000	16.0011	-2.9011
8	14.7500	14.3697	0.3803
9	13.9300	12.7383	1.1917
10	5.4600	11.1069	-5.6469
11	6.0330	9.4755	-3.4425
12	7.5500	7.8441	-0.2941
13	6.2500	6.2127	0.0373
14	7.5170	4.5813	2.9357
15	10.9500	2.9499	8.0001
16	21.3500	12.2370	9.1130
17	9.6670	10.6056	-0.9386
18	8.3330	8.9742	-0.6412
19	6.6670	7.3428	-0.6758
20	3.5660	5.7114	-2.1454
21	41.9170	23.4718	18.4452
22	16.8330	21.8404	-5.0074
23	10.3330	20.2090	-9.8760
24	13.6670	18.5776	-4.9106
25	13.5830	16.9462	-3.3632
26	20.8500	18.9278	1.9222
27	16.6670	17.2963	-0.6293
28	11.3830	15.6649	-4.2819
29	13.7500	14.0335	-0.2835
30	11.6830	12.4021	-0.7191
31	7.6500	10.7707	-3.1207
32	12.1500	9.1393	3.0107
33	6.7830	7.5079	-0.7249
34	5.7000	5.8765	-0.1765
35	6.9670	4.2451	2.7219
36	11.5000	14.5397	-3.0397
37	13.7330	12.9083	0.8247
38	7.6000	11.2769	-3.6769
39	5.0670	9.6455	-4.5785
40	12.5830	8.0141	4.5689
41	7.2000	6.3827	0.8173
42	3.8330	4.7513	-0.9183
43	6.6500	3.1199	3.5301
44	3.1830	1.4885	1.6945
45	2.9160	-0.1430	3.0590
46	39.5830	22.4389	17.1441

47	21.1670	20.8075	0.3595
48	12.7500	19.1761	-6.4261
49	12.1670	17.5447	-5.3777
50	14.0830	15.9133	-1.8303
51	4.7500	14.2819	-9.5319
52	12.2500	12.6505	-0.4005
53	7.7500	11.0191	-3.2691
54	12.0830	9.3877	2.6953
55	7.2500	7.7562	-0.5062
56	17.0830	18.0509	-0.9679
57	15.1670	16.4194	-1.2524
58	16.8330	14.7880	2.0450
59	20.7000	13.1566	7.5434
60	11.3000	11.5252	-0.2252

Sum of Residuals	0
Sum of Squared Residuals	1760.0805
Predicted Resid SS (Press)	2394.8191


RESIDUAL
20
15
10
5
0
-5
-10
Residual
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0
Predicted Value of TIME PRED

Obs	Dep Var TIME	Predict Value	Std Err Predict	Residual	Std Err Residual	Student Residual
1	32.0000	29.4864	2.415	2.5136	5.232	0.480
2	40.6700	27.8550	2.364	12.8150	5.256	2.438
3	16.5800	26.2236	2.349	-9.6436	5.262	-1.833
4	30.2500	24.5922	2.370	5.6578	5.253	1.077
5	16.3300	22.9608	2.428	-6.6308	5.226	-1.269
6	12.6600	17.6325	2.198	-4.9725	5.327	-0.933
7	13.1000	16.0011	2.032	-2.9011	5.393	-0.538
8	14.7500	14.3697	1.897	0.3803	5.441	0.070
9	13.9300	12.7383	1.802	1.1917	5.474	0.218
10	5.4600	11.1069	1.751	-5.6469	5.490	-1.029
11	6.0330	9.4755	1.749	-3.4425	5.491	-0.627
12	7.5500	7.8441	1.796	-0.2941	5.476	-0.054
13	6.2500	6.2127	1.888	0.0373	5.445	0.007
14	7.5170	4.5813	2.019	2.9357	5.397	0.544
15	10.9500	2.9499	2.183	8.0001	5.333	1.500
16	21.3500	12.2370	2.415	9.1130	5.232	1.742
17	9.6670	10.6056	2.364	-0.9386	5.256	-0.179
18	8.3330	8.9742	2.349	-0.6412	5.262	-0.122
19	6.6670	7.3428	2.370	-0.6758	5.253	-0.129
20	3.5660	5.7114	2.428	-2.1454	5.226	-0.410
21	41.9170	23.4718	2.428	18.4452	5.226	3.529
22	16.8330	21.8404	2.370	-5.0074	5.253	-0.953
23	10.3330	20.2090	2.349	-9.8760	5.262	-1.877
24	13.6670	18.5776	2.364	-4.9106	5.256	-0.934
25	13.5830	16.9462	2.415	-3.3632	5.232	-0.643
26	20.8500	18.9278	2.113	1.9222	5.361	0.359
27	16.6670	17.2963	1.917	-0.6293	5.434	-0.116
28	11.3830	15.6649	1.749	-4.2819	5.491	-0.780
29	13.7500	14.0335	1.618	-0.2835	5.531	-0.051
30	11.6830	12.4021	1.532	-0.7191	5.555	-0.129
31	7.6500	10.7707	1.501	-3.1207	5.564	-0.561
32	12.1500	9.1393	1.526	3.0107	5.557	0.542
33	6.7830	7.5079	1.607	-0.7249	5.534	-0.131
34	5.7000	5.8765	1.734	-0.1765	5.496	-0.032
35	6.9670	4.2451	1.899	2.7219	5.441	0.500
36	11.5000	14.5397	1.899	-3.0397	5.441	-0.559
37	13.7330	12.9083	1.734	0.8247	5.496	0.150
38	7.6000	11.2769	1.607	-3.6769	5.534	-0.664
39	5.0670	9.6455	1.526	-4.5785	5.557	-0.824
40	12.5830	8.0141	1.501	4.5689	5.564	0.821
41	7.2000	6.3827	1.532	0.8173	5.555	0.147
42	3.8330	4.7513	1.618	-0.9183	5.531	-0.166
43	6.6500	3.1199	1.749	3.5301	5.491	0.643
44	3.1830	1.4885	1.917	1.6945	5.434	0.312
45	2.9160	-0.1430	2.113	3.0590	5.361	0.571
46	39.5830	22.4389	1.972	17.1441	5.415	3.166
47	21.1670	20.8075	1.810	0.3595	5.471	0.066
48	12.7500	19.1761	1.684	-6.4261	5.511	-1.166

49	12.1670	17.5447	1.603	-5.3777	5.535	-0.972
50	14.0830	15.9133	1.574	-1.8303	5.544	-0.330
51	4.7500	14.2819	1.599	-9.5319	5.536	-1.722
52	12.2500	12.6505	1.677	-0.4005	5.513	-0.073
53	7.7500	11.0191	1.800	-3.2691	5.474	-0.597
54	12.0830	9.3877	1.960	2.6953	5.419	0.497
55	7.2500	7.7562	2.149	-0.5062	5.347	-0.095
56	17.0830	18.0509	2.003	-0.9679	5.404	-0.179
57	15.1670	16.4194	1.894	-1.2524	5.442	-0.230
58	16.8330	14.7880	1.828	2.0450	5.465	0.374
59	20.7000	13.1566	1.807	7.5434	5.472	1.379
60	11.3000	11.5252	1.834	-0.2252	5.463	-0.041

```
                               Cook's
 Obs    -2-1-0 1 2                  D

   1  |      |      |           0.007
   2  |      |****  |           0.172
   3  |   ***|      |           0.096
   4  |      |**    |           0.034
   5  |    **|      |           0.050
   6  |     *|      |           0.021
   7  |     *|      |           0.006
   8  |      |      |           0.000
   9  |      |      |           0.001
  10  |    **|      |           0.015
  11  |     *|      |           0.006
  12  |      |      |           0.000
  13  |      |      |           0.000
  14  |      |*     |           0.006
  15  |      |**    |           0.054
  16  |      |***   |           0.092
  17  |      |      |           0.001
  18  |      |      |           0.000
  19  |      |      |           0.000
  20  |      |      |           0.005
  21  |      |******|           0.384
  22  |     *|      |           0.026
  23  |   ***|      |           0.100
  24  |     *|      |           0.025
  25  |     *|      |           0.013
  26  |      |      |           0.003
  27  |      |      |           0.000
  28  |     *|      |           0.009
  29  |      |      |           0.000
  30  |      |      |           0.000
  31  |     *|      |           0.003
  32  |      |*     |           0.003
  33  |      |      |           0.000
  34  |      |      |           0.000
  35  |      |*     |           0.004
  36  |     *|      |           0.005
  37  |      |      |           0.000
  38  |     *|      |           0.005
  39  |     *|      |           0.007
  40  |      |*     |           0.007
  41  |      |      |           0.000
  42  |      |      |           0.000
  43  |      |*     |           0.006
  44  |      |      |           0.002
  45  |      |*     |           0.007
  46  |      |******|           0.190
  47  |      |      |           0.000
  48  |    **|      |           0.018
```

```
  49  |       *|       |   0.011
  50  |        |       |   0.001
  51  |     ***|       |   0.035
  52  |        |       |   0.000
  53  |       *|       |   0.006
  54  |        |       |   0.005
  55  |        |       |   0.000
  56  |        |       |   0.001
  57  |        |       |   0.001
  58  |        |       |   0.002
  59  |        |**     |   0.030
  60  |        |       |   0.000

Sum of Residuals                        0
Sum of Squared Residuals        1760.0805
Predicted Resid SS (Press)      2394.8191
```

EXPERIMENT 1: GDSS VERSUS FACILITATED-MANUAL
REGRESSION ANALYSIS USING INDICATOR VARIABLES
INCLUDING FACILITATOR AS AN INDEPENDENT VARIABLE

Model: MODEL1
Dependent Variable: TIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	2707.71565	386.81652	11.563	0.0001
Error	52	1739.55455	33.45297		
C Total	59	4447.27020			

Root MSE	5.78385	R-square	0.6088
Dep Mean	13.21183	Adj R-sq	0.5562
C.V.	43.77783		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	11.668915	15.98008607	0.730	0.4685
GROUP1	1	6.490289	9.13553980	0.710	0.4806
GROUP2	1	4.721847	9.08270204	0.520	0.6054
GROUP3	1	-9.974126	3.67063696	-2.717	0.0089
DAY	1	-5.031379	1.77820518	-2.829	0.0066
INTERVAL	1	-1.596408	0.29900938	-5.339	0.0001
FACILITY	1	10.372573	4.55731882	2.276	0.0270
FACILITR	1	2.873658	3.66860663	0.783	0.4370

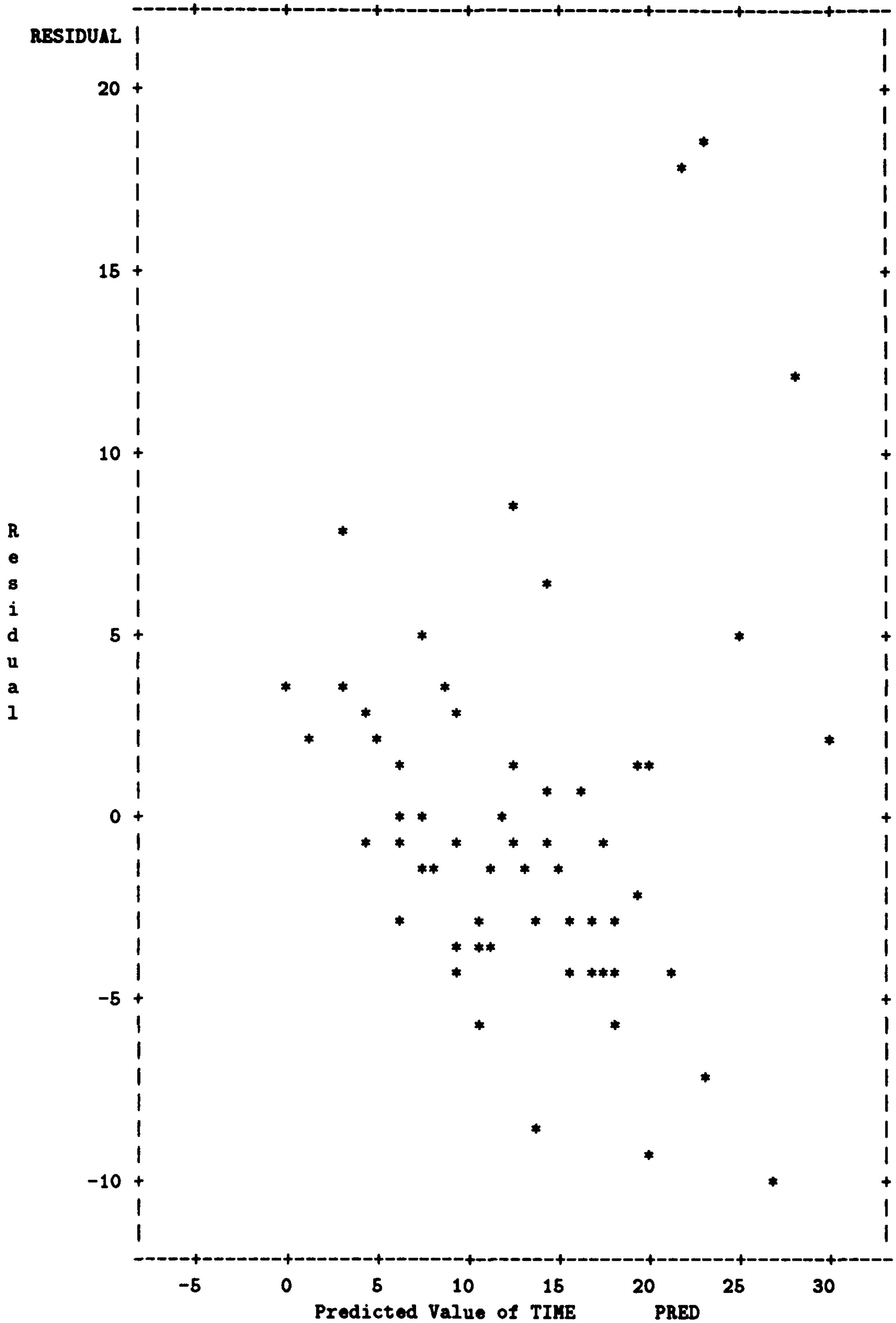
Variable	DF	Variance Inflation
INTERCEP	1	0.00000000
GROUP1	1	28.06636971
GROUP2	1	20.55011136
GROUP3	1	5.37015590
DAY	1	1.41781737
INTERVAL	1	1.29510022
FACILITY	1	9.31269488
FACILITR	1	32.68819599

Durbin-Watson D	1.988
(For Number of Obs.)	60
1st Order Autocorrelation	0.004

Obs	Dep Var TIME	Predict Value	Residual
1	32.0000	29.8090	2.1910
2	40.6700	28.2126	12.4574
3	16.5800	26.6162	-10.0362
4	30.2500	25.0198	5.2302
5	16.3300	23.4234	-7.0934
6	12.6600	17.2787	-4.6187
7	13.1000	15.6823	-2.5823
8	14.7500	14.0859	0.6641
9	13.9300	12.4895	1.4405
10	5.4600	10.8931	-5.4331
11	6.0330	9.2967	-3.2637
12	7.5500	7.7003	-0.1503
13	6.2500	6.1039	0.1461
14	7.5170	4.5075	3.0095
15	10.9500	2.9111	8.0389
16	21.3500	12.5596	8.7904
17	9.6670	10.9632	-1.2962
18	8.3330	9.3668	-1.0338
19	6.6670	7.7704	-1.1034
20	3.5660	6.1740	-2.6080
21	41.9170	23.0092	18.9078
22	16.8330	21.4128	-4.5798
23	10.3330	19.8164	-9.4834
24	13.6670	18.2200	-4.5530
25	13.5830	16.6236	-3.0406
26	20.8500	19.0919	1.7581
27	16.6670	17.4955	-0.8285
28	11.3830	15.8991	-4.5161
29	13.7500	14.3027	-0.5527
30	11.6830	12.7063	-1.0233
31	7.6500	11.1099	-3.4599
32	12.1500	9.5135	2.6365
33	6.7830	7.9171	-1.1341
34	5.7000	6.3207	-0.6207
35	6.9670	4.7243	2.2427
36	11.5000	14.0605	-2.5605
37	13.7330	12.4641	1.2689
38	7.6000	10.8677	-3.2677
39	5.0670	9.2713	-4.2043
40	12.5830	7.6749	4.9081
41	7.2000	6.0785	1.1215
42	3.8330	4.4821	-0.6491
43	6.6500	2.8857	3.7643
44	3.1830	1.2893	1.8937
45	2.9160	-0.3071	3.2231
46	39.5830	21.5671	18.0159
47	21.1670	19.9707	1.1963
48	12.7500	18.3743	-5.6243

49	12.1670	16.7779	-4.6109
50	14.0830	15.1815	-1.0985
51	4.7500	13.5851	-8.8351
52	12.2500	11.9887	0.2613
53	7.7500	10.3923	-2.6423
54	12.0830	8.7959	3.2871
55	7.2500	7.1995	0.0505
56	17.0830	19.4094	-2.3264
57	15.1670	17.8130	-2.6460
58	16.8330	16.2166	0.6164
59	20.7000	14.6202	6.0798
60	11.3000	13.0238	-1.7238

Sum of Residuals 0
Sum of Squared Residuals 1739.5546
Predicted Resid SS (Press) 2469.0448


RESIDUAL
20
15
10
5
0
-5
-10
Residual
-5
0
5
10
15
20
25
30
Predicted Value of TIME PRED

Obs	Dep Var TIME	Predict Value	Std Err Predict	Residual	Std Err Residual	Student Residual
1	32.0000	29.8090	2.459	2.1910	5.235	0.419
2	40.6700	28.2126	2.416	12.4574	5.255	2.371
3	16.5800	26.6162	2.410	-10.0362	5.258	-1.909
4	30.2500	25.0198	2.441	5.2302	5.244	0.997
5	16.3300	23.4234	2.507	-7.0934	5.212	-1.361
6	12.6600	17.2787	2.252	-4.6187	5.328	-0.867
7	13.1000	15.6823	2.079	-2.5823	5.397	-0.478
8	14.7500	14.0859	1.939	0.6641	5.449	0.122
9	13.9300	12.4895	1.836	1.4405	5.485	0.263
10	5.4600	10.8931	1.778	-5.4331	5.504	-0.987
11	6.0330	9.2967	1.770	-3.2637	5.506	-0.593
12	7.5500	7.7003	1.811	-0.1503	5.493	-0.027
13	6.2500	6.1039	1.900	0.1461	5.463	0.027
14	7.5170	4.5075	2.029	3.0095	5.416	0.556
15	10.9500	2.9111	2.191	8.0389	5.353	1.502
16	21.3500	12.5596	2.459	8.7904	5.235	1.679
17	9.6670	10.9632	2.416	-1.2962	5.255	-0.247
18	8.3330	9.3668	2.410	-1.0338	5.258	-0.197
19	6.6670	7.7704	2.441	-1.1034	5.244	-0.210
20	3.5660	6.1740	2.507	-2.6080	5.212	-0.500
21	41.9170	23.0092	2.507	18.9078	5.212	3.628
22	16.8330	21.4128	2.441	-4.5798	5.244	-0.873
23	10.3330	19.8164	2.410	-9.4834	5.258	-1.804
24	13.6670	18.2200	2.416	-4.5530	5.255	-0.866
25	13.5830	16.6236	2.459	-3.0406	5.235	-0.581
26	20.8500	19.0919	2.131	1.7581	5.377	0.327
27	16.6670	17.4955	1.941	-0.8285	5.448	-0.152
28	11.3830	15.8991	1.781	-4.5161	5.503	-0.821
29	13.7500	14.3027	1.659	-0.5527	5.541	-0.100
30	11.6830	12.7063	1.586	-1.0233	5.562	-0.184
31	7.6500	11.1099	1.567	-3.4599	5.568	-0.621
32	12.1500	9.5135	1.605	2.6365	5.557	0.474
33	6.7830	7.9171	1.695	-1.1341	5.530	-0.205
34	5.7000	6.3207	1.830	-0.6207	5.487	-0.113
35	6.9670	4.7243	2.001	2.2427	5.427	0.413
36	11.5000	14.0605	2.001	-2.5605	5.427	-0.472
37	13.7330	12.4641	1.830	1.2689	5.487	0.231
38	7.6000	10.8677	1.695	-3.2677	5.530	-0.591
39	5.0670	9.2713	1.605	-4.2043	5.557	-0.757
40	12.5830	7.6749	1.567	4.9081	5.568	0.882
41	7.2000	6.0785	1.586	1.1215	5.562	0.202
42	3.8330	4.4821	1.659	-0.6491	5.541	-0.117
43	6.6500	2.8857	1.781	3.7643	5.503	0.684
44	3.1830	1.2893	1.941	1.8937	5.448	0.348
45	2.9160	-0.3071	2.131	3.2231	5.377	0.599
46	39.5830	21.5671	2.271	18.0159	5.320	3.387

47	21.1670	19.9707	2.107	1.1963	5.386	0.222
48	12.7500	18.3743	1.976	-5.6243	5.436	-1.035
49	12.1670	16.7779	1.883	-4.6109	5.469	-0.843
50	14.0830	15.1815	1.835	-1.0985	5.485	-0.200
51	4.7500	13.5851	1.835	-8.8351	5.485	-1.611
52	12.2500	11.9887	1.883	0.2613	5.469	0.048
53	7.7500	10.3923	1.976	-2.6423	5.436	-0.486
54	12.0830	8.7959	2.107	3.2871	5.386	0.610
55	7.2500	7.1995	2.271	0.0505	5.320	0.010
56	17.0830	19.4094	2.655	-2.3264	5.139	-0.453
57	15.1670	17.8130	2.604	-2.6460	5.165	-0.512
58	16.8330	16.2166	2.587	0.6164	5.173	0.119
59	20.7000	14.6202	2.604	6.0798	5.165	1.177
60	11.3000	13.0238	2.655	-1.7238	5.139	-0.335

```
                        Cook's
Obs   -2-1-0 1 2             D

  1  |       |       |   0.005
  2  |       |****   |   0.149
  3  |    ***|       |   0.096
  4  |       |*      |   0.027
  5  |     **|       |   0.054
  6  |      *|       |   0.017
  7  |       |       |   0.004
  8  |       |       |   0.000
  9  |       |       |   0.001
 10  |      *|       |   0.013
 11  |      *|       |   0.005
 12  |       |       |   0.000
 13  |       |       |   0.000
 14  |       |*      |   0.005
 15  |       |***    |   0.047
 16  |       |***    |   0.078
 17  |       |       |   0.002
 18  |       |       |   0.001
 19  |       |       |   0.001
 20  |      *|       |   0.007
 21  |       |******|   0.381
 22  |      *|       |   0.021
 23  |    ***|       |   0.085
 24  |      *|       |   0.020
 25  |      *|       |   0.009
 26  |       |       |   0.002
 27  |       |       |   0.000
 28  |      *|       |   0.009
 29  |       |       |   0.000
 30  |       |       |   0.000
 31  |      *|       |   0.004
 32  |       |       |   0.002
 33  |       |       |   0.000
 34  |       |       |   0.000
 35  |       |       |   0.003
 36  |       |       |   0.004
 37  |       |       |   0.001
 38  |      *|       |   0.004
 39  |      *|       |   0.006
 40  |       |*      |   0.008
 41  |       |       |   0.000
 42  |       |       |   0.000
 43  |       |*      |   0.006
 44  |       |       |   0.002
 45  |       |*      |   0.007
 46  |       |******|   0.261
 47  |       |       |   0.001
 48  |     **|       |   0.018
```

```
  49  |      *|      |   0.011
  50  |       |      |   0.001
  51  |    ***|      |   0.036
  52  |       |      |   0.000
  53  |       |      |   0.004
  54  |       |*     |   0.007
  55  |       |      |   0.000
  56  |       |      |   0.007
  57  |      *|      |   0.008
  58  |       |      |   0.000
  59  |       |**    |   0.044
  60  |       |      |   0.004

Sum of Residuals                    0
Sum of Squared Residuals    1739.5546
Predicted Resid SS (Press)  2469.0448
```

EXPERIMENT 1: GDSS VERSUS FACILITATED-MANUAL
TEST FOR NORMALITY OF RESIDUALS
RUN EXP1ARSD WITHOUT FACILITATOR

Univariate Procedure

Variable=RESIDUAL

Moments

N	60	Sum Wgts	60
Mean	0	Sum	0
Std Dev	5.461857	Variance	29.83189
Skewness	1.201903	Kurtosis	2.760757
USS	1760.081	CSS	1760.081
CV	.	Std Mean	0.705123
T:Mean=0	0	Prob>|T|	1.0000
Num ^= 0	60	Num > 0	24
M(Sign)	-6	Prob>|M|	0.1550
Sgn Rank	-132	Prob>|S|	0.3354
W:Normal	0.910569	Prob<W	0.0002

Quantiles(Def=5)

100% Max	18.4452	99%	18.4452
75% Q3	2.2793	95%	10.964
50% Med	-0.56775	90%	6.6006
25% Q1	-3.31615	10%	-5.5123
0% Min	-9.876	5%	-8.08135
		1%	-9.876
Range	28.3212		
Q3-Q1	5.59545		
Mode	-9.876		

Extremes

Lowest	Obs	Highest	Obs
-9.876(	23)	8.0001(	15)
-9.6436(	3)	9.113(	16)
-9.5319(	51)	12.815(	2)
-6.6308(	5)	17.1441(	46)
-6.4261(	48)	18.4452(	21)

Univariate Procedure

Variable=RESIDUAL

Moments

N	60	Sum Wgts	60
Mean	0	Sum	0
Std Dev	5.461857	Variance	29.83189
Skewness	1.201903	Kurtosis	2.760757
USS	1760.081	CSS	1760.081
CV	.	Std Mean	0.705123
T:Mean=0	0	Prob>|T|	1.0000
Num ^= 0	60	Num > 0	24
M(Sign)	-6	Prob>|M|	0.1550
Sgn Rank	-132	Prob>|S|	0.3354

Quantiles(Def=5)

100% Max	18.4452	99%	18.4452
75% Q3	2.2793	95%	10.964
50% Med	-0.56775	90%	6.6006
25% Q1	-3.31615	10%	-5.5123
0% Min	-9.876	5%	-8.08135
		1%	-9.876
Range	28.3212		
Q3-Q1	5.59545		
Mode	-9.876		

Extremes

Lowest	Obs	Highest	Obs
-9.876(	23)	8.0001(	15)
-9.6436(	3)	9.113(	16)
-9.5319(	51)	12.815(	2)
-6.6308(	5)	17.1441(	46)
-6.4261(	48)	18.4452(	21)

Univariate Procedure

Variable=RESIDUAL

```
Stem Leaf                     #             Boxplot
  18 4                        1                0
  16 1                        1                0
  14
  12 8                        1                0
  10
   8 01                       2                |
   6 5                        1                |
   4 67                       2                |
   2 05779015                 8             +-----+
   0 04488279                 8             |  +  |
  -0 8309977766543322        16             *-----*
  -2 74431091                 8             +-----+
  -4 6400963                  7                |
  -6 64                       2                |
  -8 965                      3                |
     ----+----+----+----+
```

Normal Probability Plot

```
  19+                                               *
    |                                           *
    |
    |                                         *   ++++
    |                                          +++
    |                                     *++++
    |                                  ++*+
   5+                               +++**
    |                            ++******
    |                        +++****
    |                    *******
    |                ****+
    |           *****+
    |        * *+++
  -9+ *   *+*++
    +----+----+----+----+----+----+----+----+----+----+
        -2        -1         0        +1        +2
```

EXPERIMENT 1: GDSS VERSUS FACILITATED-MANUAL
TEST FOR NORMALITY OF RESIDUALS
RUN EXP1FRSD WITH FACILITATOR

Univariate Procedure

Variable=RESIDUAL

Moments

N	60	Sum Wgts	60
Mean	0	Sum	0
Std Dev	5.429916	Variance	29.48398
Skewness	1.355671	Kurtosis	3.374829
USS	1739.555	CSS	1739.555
CV	.	Std Mean	0.700999
T:Mean=0	0	Prob>|T|	1.0000
Num ^= 0	60	Num > 0	26
M(Sign)	-4	Prob>|M|	0.3663
Sgn Rank	-123	Prob>|S|	0.3696
W:Normal	0.901437	Prob<W	0.0001

Quantiles(Def=5)

100% Max	18.9078	99%	18.9078
75% Q3	2.04235	95%	10.6239
50% Med	-0.7388	90%	5.655
25% Q1	-3.15215	10%	-5.0259
0% Min	-10.0362	5%	-7.96425
		1%	-10.0362
Range	28.944		
Q3-Q1	5.1945		
Mode	-10.0362		

Extremes

Lowest	Obs	Highest	Obs
-10.0362(	3)	8.0389(	15)
-9.4834(	23)	8.7904(	16)
-8.8351(	51)	12.4574(	2)
-7.0934(	5)	18.0159(	46)
-5.6243(	48)	18.9078(	21)

Univariate Procedure

Variable=RESIDUAL

Moments

N	60	Sum Wgts	60
Mean	0	Sum	0
Std Dev	5.429916	Variance	29.48398
Skewness	1.355671	Kurtosis	3.374829
USS	1739.555	CSS	1739.555
CV	.	Std Mean	0.700999
T:Mean=0	0	Prob>|T|	1.0000
Num ^= 0	60	Num > 0	26
M(Sign)	-4	Prob>|M|	0.3663
Sgn Rank	-123	Prob>|S|	0.3696

Quantiles(Def=5)

100% Max	18.9078	99%	18.9078
75% Q3	2.04235	95%	10.6239
50% Med	-0.7388	90%	5.655
25% Q1	-3.15215	10%	-5.0259
0% Min	-10.0362	5%	-7.96425
		1%	-10.0362
Range	28.944		
Q3-Q1	5.1945		
Mode	-10.0362		

Extremes

Lowest	Obs	Highest	Obs
-10.0362(	3)	8.0389(	15)
-9.4834(	23)	8.7904(	16)
-8.8351(	51)	12.4574(	2)
-7.0934(	5)	18.0159(	46)
-5.6243(	48)	18.9078(	21)

Univariate Procedure

Variable=RESIDUAL

```
Stem Leaf                     #             Boxplot
  18 09                       2                *
  16
  14
  12 5                        1                0
  10
   8 08                       2                |
   6 1                        1                |
   4 92                       2                |
   2 2260238                  7             +-----+
   0 11367123489             11             |  +  |
  -0 731110086662            12             *-----*
  -2 5330666663              10             +-----+
  -4 64666652                 8                |
  -6 1                        1                |
  -8 58                       2                |
 -10 0                        1                |
     ----+----+----+----+
```

```
                      Normal Probability Plot
 19+                                                 *   *
   |
   |
 13+                                               *      +++
   |                                                 ++++
   |                                             *+*++
  7+                                           ++*
   |                                       +++**
   |                                   ++++****
  1+                               ++*****
   |                            *****
   |                       *****
 -5+                 ******+
   |               * +++
   |           *+*++
-11+      *+*++
    +----+----+----+----+----+----+----+----+----+----+
         -2        -1         0        +1        +2
```

EXPERIMENT 1: GDSS VERSUS FACILITATED-MANUAL
REGRESSION ANALYSIS USING INDICATOR VARIABLES
TIME TRANSFORMED USING (TIME)^(.5)

Model: MODEL1
Dependent Variable: TIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	45.51752	7.58625	17.871	0.0001
Error	53	22.49830	0.42450		
C Total	59	68.01582			

Root MSE	0.65153	R-square	0.6692
Dep Mean	3.47538	Adj R-sq	0.6318
C.V.	18.74714		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	5.004143	0.24446697	20.470	0.0001
GROUP1	1	-0.070729	0.26822803	-0.264	0.7930
GROUP2	1	-0.249659	0.31601228	-0.790	0.4330
GROUP3	1	-1.306354	0.38751985	-3.371	0.0014
DAY	1	-0.566285	0.17766434	-3.187	0.0024
INTERVAL	1	-0.226474	0.03330435	-6.800	0.0001
FACILITY	1	0.800725	0.29800933	2.687	0.0096

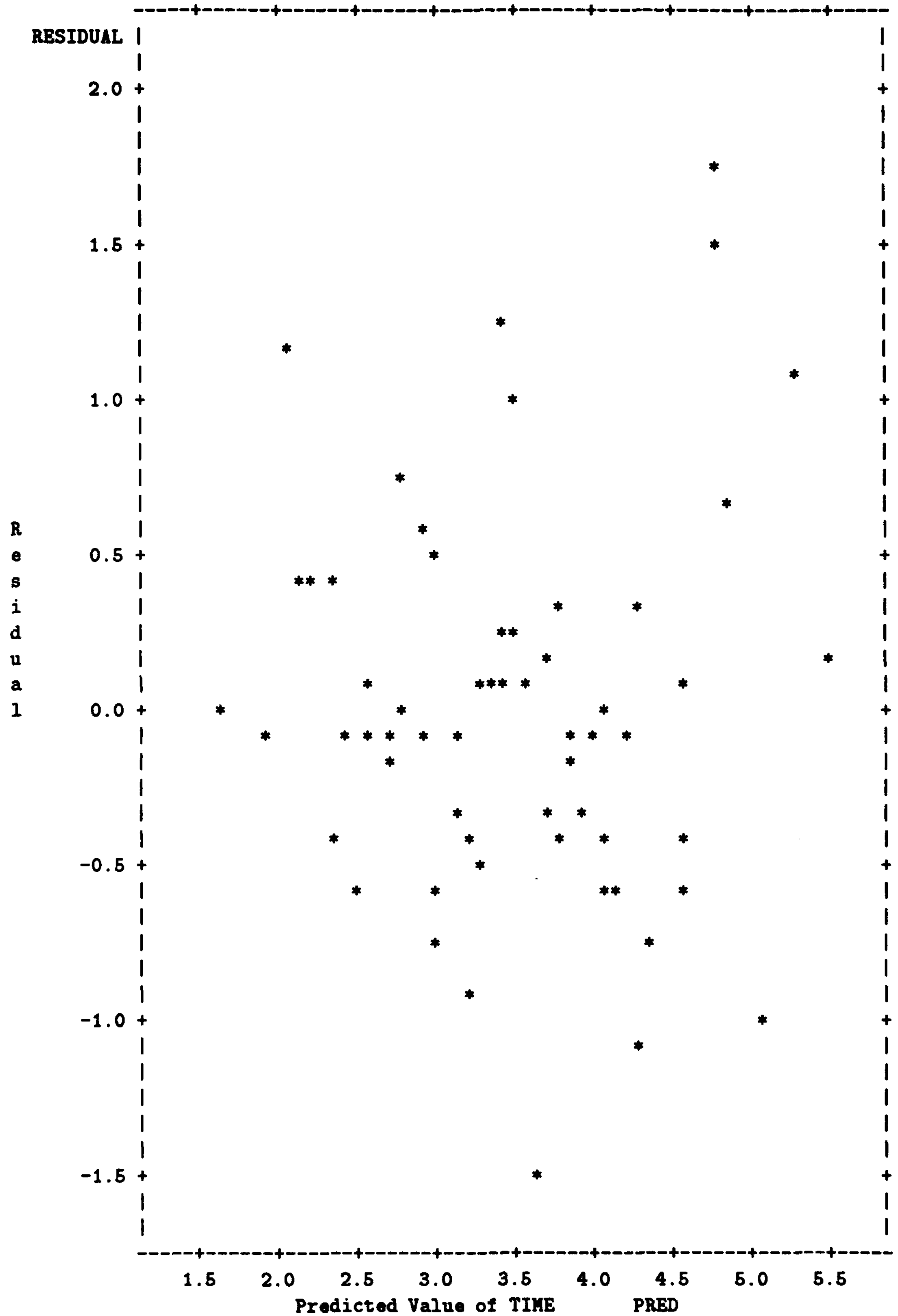
Variable	DF	Variance Inflation
INTERCEP	1	0.00000000
GROUP1	1	1.90672055
GROUP2	1	1.96043696
GROUP3	1	4.71685858
DAY	1	1.11536758
INTERVAL	1	1.26618320
FACILITY	1	3.13817538

Durbin-Watson D	2.027
(For Number of Obs.)	60
1st Order Autocorrelation	-0.014

Obs	Dep Var TIME	Predict Value	Residual
1	5.6569	5.5077	0.1492
2	6.3773	5.2812	1.0961
3	4.0719	5.0547	-0.9829
4	5.5000	4.8282	0.6718
5	4.0410	4.6018	-0.5607
6	3.5581	4.1407	-0.5826
7	3.6194	3.9142	-0.2948
8	3.8406	3.6877	0.1529
9	3.7323	3.4612	0.2711
10	2.3367	3.2348	-0.8981
11	2.4562	3.0083	-0.5521
12	2.7477	2.7818	-0.0341
13	2.5000	2.5553	-0.0553
14	2.7417	2.3289	0.4129
15	3.3091	2.1024	1.2067
16	4.6206	3.3956	1.2250
17	3.1092	3.1692	-0.0600
18	2.8867	2.9427	-0.0560
19	2.5821	2.7162	-0.1342
20	1.8884	2.4897	-0.6014
21	6.4743	4.7625	1.7119
22	4.1028	4.5360	-0.4332
23	3.2145	4.3095	-1.0950
24	3.6969	4.0830	-0.3861
25	3.6855	3.8566	-0.1710
26	4.5662	4.2720	0.2941
27	4.0825	4.0456	0.0370
28	3.3739	3.8191	-0.4452
29	3.7081	3.5926	0.1155
30	3.4180	3.3661	0.0519
31	2.7659	3.1397	-0.3738
32	3.4857	2.9132	0.5725
33	2.6044	2.6867	-0.0823
34	2.3875	2.4602	-0.0728
35	2.6395	2.2338	0.4057
36	3.3912	3.7058	-0.3146
37	3.7058	3.4793	0.2265
38	2.7568	3.2528	-0.4960
39	2.2510	3.0263	-0.7753
40	3.5473	2.7999	0.7474
41	2.6833	2.5734	0.1099
42	1.9578	2.3469	-0.3891
43	2.5788	2.1204	0.4583
44	1.7841	1.8940	-0.1099
45	1.7076	1.6675	0.0401
46	6.2915	4.7777	1.5138
47	4.6008	4.5512	0.0496
48	3.5707	4.3247	-0.7540

49	3.4881	4.0982	-0.6101
50	3.7527	3.8718	-0.1190
51	2.1794	3.6453	-1.4658
52	3.5000	3.4188	0.0812
53	2.7839	3.1923	-0.4085
54	3.4761	2.9659	0.5102
55	2.6926	2.7394	-0.0468
56	4.1332	4.2114	-0.0782
57	3.8945	3.9849	-0.0904
58	4.1028	3.7584	0.3444
59	4.5497	3.5320	1.0178
60	3.3615	3.3055	0.0561

Sum of Residuals	0
Sum of Squared Residuals	22.4983
Predicted Resid SS (Press)	29.9063


RESIDUAL
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Residual
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
Predicted Value of TIME PRED

Obs	Dep Var TIME	Predict Value	Std Err Predict	Residual	Std Err Residual	Student Residual
1	5.6569	5.5077	0.273	0.1492	0.592	0.252
2	6.3773	5.2812	0.267	1.0961	0.594	1.845
3	4.0719	5.0547	0.266	-0.9829	0.595	-1.652
4	5.5000	4.8282	0.268	0.6718	0.594	1.131
5	4.0410	4.6018	0.274	-0.5607	0.591	-0.949
6	3.5581	4.1407	0.248	-0.5826	0.602	-0.967
7	3.6194	3.9142	0.230	-0.2948	0.610	-0.484
8	3.8406	3.6877	0.215	0.1529	0.615	0.248
9	3.7323	3.4612	0.204	0.2711	0.619	0.438
10	2.3367	3.2348	0.198	-0.8981	0.621	-1.447
11	2.4562	3.0083	0.198	-0.5521	0.621	-0.889
12	2.7477	2.7818	0.203	-0.0341	0.619	-0.055
13	2.5000	2.5553	0.213	-0.0553	0.616	-0.090
14	2.7417	2.3289	0.228	0.4129	0.610	0.677
15	3.3091	2.1024	0.247	1.2067	0.603	2.001
16	4.6206	3.3956	0.273	1.2250	0.592	2.071
17	3.1092	3.1692	0.267	-0.0600	0.594	-0.101
18	2.8867	2.9427	0.266	-0.0560	0.595	-0.094
19	2.5821	2.7162	0.268	-0.1342	0.594	-0.226
20	1.8884	2.4897	0.274	-0.6014	0.591	-1.018
21	6.4743	4.7625	0.274	1.7119	0.591	2.897
22	4.1028	4.5360	0.268	-0.4332	0.594	-0.729
23	3.2145	4.3095	0.266	-1.0950	0.595	-1.840
24	3.6969	4.0830	0.267	-0.3861	0.594	-0.650
25	3.6855	3.8566	0.273	-0.1710	0.592	-0.289
26	4.5662	4.2720	0.239	0.2941	0.606	0.485
27	4.0825	4.0456	0.217	0.0370	0.614	0.060
28	3.3739	3.8191	0.198	-0.4452	0.621	-0.717
29	3.7081	3.5926	0.183	0.1155	0.625	0.185
30	3.4180	3.3661	0.173	0.0519	0.628	0.083
31	2.7659	3.1397	0.170	-0.3738	0.629	-0.594
32	3.4857	2.9132	0.173	0.5725	0.628	0.911
33	2.6044	2.6867	0.182	-0.0823	0.626	-0.132
34	2.3875	2.4602	0.196	-0.0728	0.621	-0.117
35	2.6395	2.2338	0.215	0.4057	0.615	0.660
36	3.3912	3.7058	0.215	-0.3146	0.615	-0.511
37	3.7058	3.4793	0.196	0.2265	0.621	0.365
38	2.7568	3.2528	0.182	-0.4960	0.626	-0.793
39	2.2510	3.0263	0.173	-0.7753	0.628	-1.234
40	3.5473	2.7999	0.170	0.7474	0.629	1.188
41	2.6833	2.5734	0.173	0.1099	0.628	0.175
42	1.9578	2.3469	0.183	-0.3891	0.625	-0.622
43	2.5788	2.1204	0.198	0.4583	0.621	0.738
44	1.7841	1.8940	0.217	-0.1099	0.614	-0.179
45	1.7076	1.6675	0.239	0.0401	0.606	0.066
46	6.2915	4.7777	0.223	1.5138	0.612	2.473
47	4.6008	4.5512	0.205	0.0496	0.619	0.080
48	3.5707	4.3247	0.190	-0.7540	0.623	-1.210

49	3.4881	4.0982	0.181	-0.6101	0.626	-0.975
50	3.7527	3.8718	0.178	-0.1190	0.627	-0.190
51	2.1794	3.6453	0.181	-1.4658	0.626	-2.342
52	3.5000	3.4188	0.190	0.0812	0.623	0.130
53	2.7839	3.1923	0.204	-0.4085	0.619	-0.660
54	3.4761	2.9659	0.222	0.5102	0.613	0.833
55	2.6926	2.7394	0.243	-0.0468	0.605	-0.077
56	4.1332	4.2114	0.226	-0.0782	0.611	-0.128
57	3.8945	3.9849	0.214	-0.0904	0.615	-0.147
58	4.1028	3.7584	0.207	0.3444	0.618	0.557
59	4.5497	3.5320	0.204	1.0178	0.619	1.645
60	3.3615	3.3055	0.207	0.0561	0.618	0.091

```
                          Cook's
Obs   -2-1-0 1 2             D

  1 |      |      |   0.002
  2 |      |***   |   0.098
  3 |   ***|      |   0.078
  4 |      |**    |   0.037
  5 |     *|      |   0.028
  6 |     *|      |   0.023
  7 |      |      |   0.005
  8 |      |      |   0.001
  9 |      |      |   0.003
 10 |    **|      |   0.030
 11 |     *|      |   0.011
 12 |      |      |   0.000
 13 |      |      |   0.000
 14 |      |*     |   0.009
 15 |      |****  |   0.096
 16 |      |****  |   0.131
 17 |      |      |   0.000
 18 |      |      |   0.000
 19 |      |      |   0.001
 20 |    **|      |   0.032
 21 |      |***** |   0.259
 22 |     *|      |   0.015
 23 |   ***|      |   0.096
 24 |     *|      |   0.012
 25 |      |      |   0.003
 26 |      |      |   0.005
 27 |      |      |   0.000
 28 |     *|      |   0.007
 29 |      |      |   0.000
 30 |      |      |   0.000
 31 |     *|      |   0.004
 32 |      |*     |   0.009
 33 |      |      |   0.000
 34 |      |      |   0.000
 35 |      |*     |   0.008
 36 |     *|      |   0.005
 37 |      |      |   0.002
 38 |     *|      |   0.008
 39 |    **|      |   0.016
 40 |      |**    |   0.015
 41 |      |      |   0.000
 42 |     *|      |   0.005
 43 |      |*     |   0.008
 44 |      |      |   0.001
 45 |      |      |   0.000
 46 |      |****  |   0.116
 47 |      |      |   0.000
 48 |    **|      |   0.020
```

```
49 |     *|     |  0.011
50 |      |     |  0.000
51 |  ****|     |  0.065
52 |      |     |  0.000
53 |     *|     |  0.007
54 |      |*    |  0.013
55 |      |     |  0.000
56 |      |     |  0.000
57 |      |     |  0.000
58 |      |*    |  0.005
59 |      |***  |  0.042
60 |      |     |  0.000

Sum of Residuals                        0
Sum of Squared Residuals          22.4983
Predicted Resid SS (Press)        29.9063
```

EXPERIMENT 1: GDSS VERSUS FACILITATED-MANUAL
REGRESSION ANALYSIS USING INDICATOR VARIABLES
INCLUDING FACILITATOR AND TIME TRANSFORMED USING (TIME)^(.5)

Model: MODEL1
Dependent Variable: TIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	46.14568	6.59224	15.674	0.0001
Error	52	21.87C14	0.42058		
C Total	59	68.01582			

Root MSE	0.64852	R-square	0.6785
Dep Mean	3.47538	Adj R-sq	0.6352
C.V.	18.66046		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	2.834676	1.79178494	1.582	0.1197
GROUP1	1	1.137846	1.02433257	1.111	0.2718
GROUP2	1	0.934092	1.01840808	0.917	0.3633
GROUP3	1	-1.130918	0.41157426	-2.748	0.0082
DAY	1	-0.678827	0.19938324	-3.405	0.0013
INTERVAL	1	-0.220352	0.03352676	-6.572	0.0001
FACILITY	1	1.309223	0.51099445	2.562	0.0133
FACILITR	1	0.502710	0.41134660	1.222	0.2272

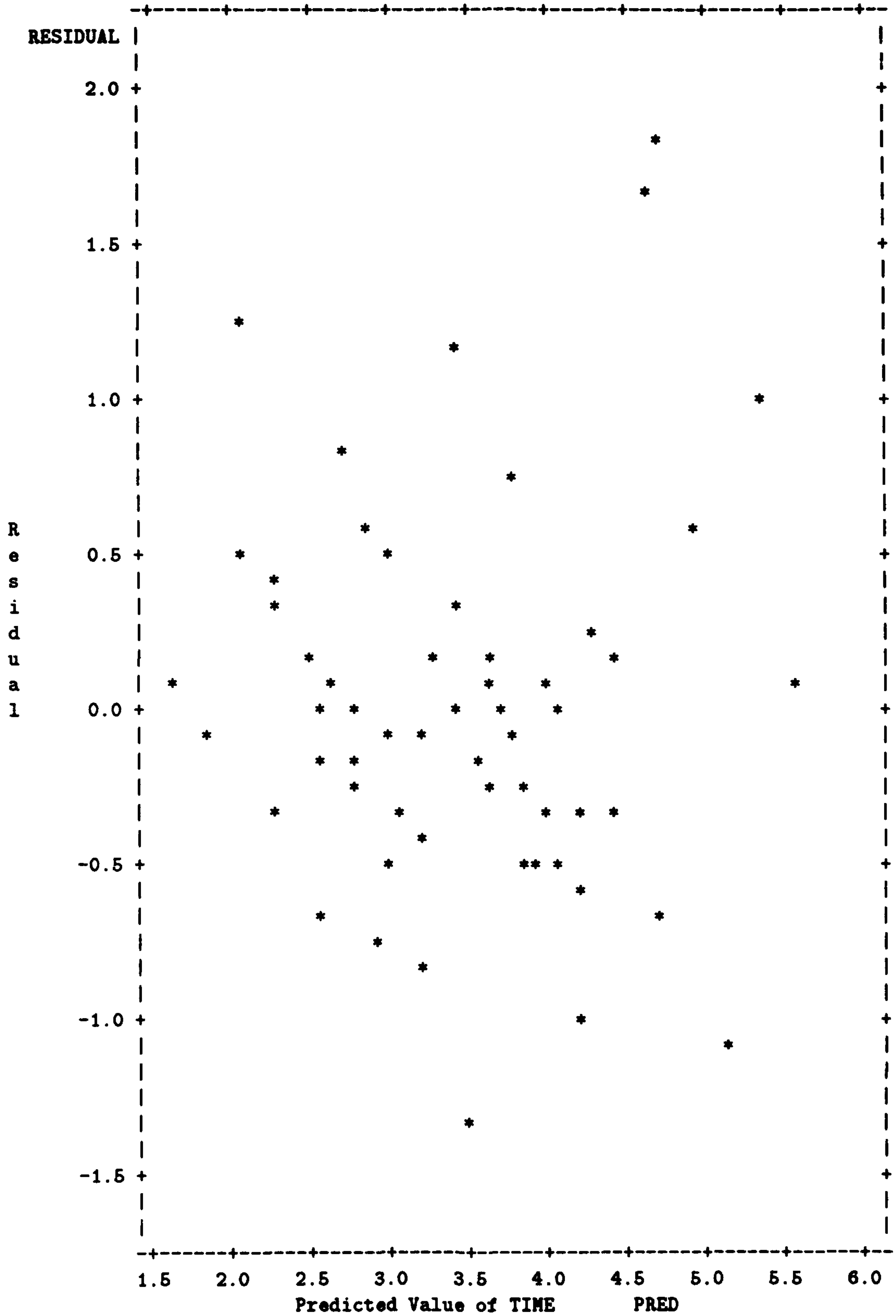
Variable	DF	Variance Inflation
INTERCEP	1	0.00000000
GROUP1	1	28.06636971
GROUP2	1	20.55011136
GROUP3	1	5.37015590
DAY	1	1.41781737
INTERVAL	1	1.29510022
FACILITY	1	9.31269488
FACILITR	1	32.68819599

Durbin-Watson D	2.134
(For Number of Obs.)	60
1st Order Autocorrelation	-0.068

Obs	Dep Var TIME	Predict Value	Residual
1	5.6569	5.5641	0.0928
2	6.3773	5.3438	1.0336
3	4.0719	5.1234	-1.0515
4	5.5000	4.9030	0.5970
5	4.0410	4.6827	-0.6417
6	3.5581	4.0788	-0.5207
7	3.6194	3.8584	-0.2390
8	3.8406	3.6381	0.2025
9	3.7323	3.4177	0.3146
10	2.3367	3.1974	-0.8607
11	2.4562	2.9770	-0.5208
12	2.7477	2.7567	-0.00893
13	2.5000	2.5363	-0.0363
14	2.7417	2.3159	0.4258
15	3.3091	2.0956	1.2135
16	4.6206	3.4521	1.1685
17	3.1092	3.2317	-0.1225
18	2.8867	3.0114	-0.1247
19	2.5821	2.7910	-0.2090
20	1.8884	2.5707	-0.6823
21	6.4743	4.6815	1.7928
22	4.1028	4.4612	-0.3584
23	3.2145	4.2408	-1.0263
24	3.6969	4.0205	-0.3236
25	3.6855	3.8001	-0.1146
26	4.5662	4.3008	0.2654
27	4.0825	4.0804	0.00212
28	3.3739	3.8601	-0.4862
29	3.7081	3.6397	0.0684
30	3.4180	3.4194	-0.00131
31	2.7659	3.1990	-0.4331
32	3.4857	2.9786	0.5070
33	2.6044	2.7583	-0.1539
34	2.3875	2.5379	-0.1505
35	2.6395	2.3176	0.3219
36	3.3912	3.6219	-0.2308
37	3.7058	3.4016	0.3042
38	2.7568	3.1812	-0.4244
39	2.2510	2.9609	-0.7099
40	3.5473	2.7405	0.8067
41	2.6833	2.5202	0.1631
42	1.9578	2.2998	-0.3420
43	2.5788	2.0795	0.4993
44	1.7841	1.8591	-0.0750
45	1.7076	1.6388	0.0689
46	6.2915	4.6252	1.6663
47	4.6008	4.4048	0.1959
48	3.5707	4.1845	-0.6137

49	3.4881	3.9641	-0.4760
50	3.7527	3.7438	0.00898
51	2.1794	3.5234	-1.3440
52	3.5000	3.3031	0.1969
53	2.7839	3.0827	-0.2988
54	3.4761	2.8623	0.6137
55	2.6926	2.6420	0.0506
56	4.1332	4.4490	-0.3159
57	3.8945	4.2287	-0.3342
58	4.1028	4.0083	0.0945
59	4.5497	3.7880	0.7617
60	3.3615	3.5676	-0.2061

Sum of Residuals	0
Sum of Squared Residuals	21.8701
Predicted Resid SS (Press)	30.3491


RESIDUAL
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Residual
1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Predicted Value of TIME PRED

Obs	Dep Var TIME	Predict Value	Std Err Predict	Residual	Std Err Residual	Student Residual
1	5.6569	5.5641	0.276	0.0928	0.587	0.158
2	6.3773	5.3438	0.271	1.0336	0.589	1.754
3	4.0719	5.1234	0.270	-1.0515	0.590	-1.784
4	5.5000	4.9030	0.274	0.5970	0.588	1.015
5	4.0410	4.6827	0.281	-0.6417	0.584	-1.098
6	3.5581	4.0788	0.252	-0.5207	0.597	-0.872
7	3.6194	3.8584	0.233	-0.2390	0.605	-0.395
8	3.8406	3.6381	0.217	0.2025	0.611	0.331
9	3.7323	3.4177	0.206	0.3146	0.615	0.512
10	2.3367	3.1974	0.199	-0.8607	0.617	-1.395
11	2.4562	2.9770	0.198	-0.5208	0.617	-0.843
12	2.7477	2.7567	0.203	-0.00893	0.616	-0.014
13	2.5000	2.5363	0.213	-0.0363	0.613	-0.059
14	2.7417	2.3159	0.227	0.4258	0.607	0.701
15	3.3091	2.0956	0.246	1.2135	0.600	2.022
16	4.6206	3.4521	0.276	1.1685	0.587	1.991
17	3.1092	3.2317	0.271	-0.1225	0.589	-0.208
18	2.8867	3.0114	0.270	-0.1247	0.590	-0.211
19	2.5821	2.7910	0.274	-0.2090	0.588	-0.355
20	1.8884	2.5707	0.281	-0.6823	0.584	-1.167
21	6.4743	4.6815	0.281	1.7928	0.584	3.068
22	4.1028	4.4612	0.274	-0.3584	0.588	-0.610
23	3.2145	4.2408	0.270	-1.0263	0.590	-1.741
24	3.6969	4.0205	0.271	-0.3236	0.589	-0.549
25	3.6855	3.8001	0.276	-0.1146	0.587	-0.195
26	4.5662	4.3008	0.239	0.2654	0.603	0.440
27	4.0825	4.0804	0.218	0.00212	0.611	0.003
28	3.3739	3.8601	0.200	-0.4862	0.617	-0.788
29	3.7081	3.6397	0.186	0.0684	0.621	0.110
30	3.4180	3.4194	0.178	-0.00131	0.624	-0.002
31	2.7659	3.1990	0.176	-0.4331	0.624	-0.694
32	3.4857	2.9786	0.180	0.5070	0.623	0.814
33	2.6044	2.7583	0.190	-0.1539	0.620	-0.248
34	2.3875	2.5379	0.205	-0.1505	0.615	-0.245
35	2.6395	2.3176	0.224	0.3219	0.608	0.529
36	3.3912	3.6219	0.224	-0.2308	0.608	-0.379
37	3.7058	3.4016	0.205	0.3042	0.615	0.495
38	2.7568	3.1812	0.190	-0.4244	0.620	-0.684
39	2.2510	2.9609	0.180	-0.7099	0.623	-1.139
40	3.5473	2.7405	0.176	0.8067	0.624	1.292
41	2.6833	2.5202	0.178	0.1631	0.624	0.262
42	1.9578	2.2998	0.186	-0.3420	0.621	-0.551
43	2.5788	2.0795	0.200	0.4993	0.617	0.809
44	1.7841	1.8591	0.218	-0.0750	0.611	-0.123
45	1.7076	1.6388	0.239	0.0689	0.603	0.114
46	6.2915	4.6252	0.255	1.6663	0.596	2.794
47	4.6008	4.4048	0.236	0.1959	0.604	0.324
48	3.5707	4.1845	0.222	-0.6137	0.610	-1.007

49	3.4881	3.9641	0.211	-0.4760	0.613	-0.776
50	3.7527	3.7438	0.206	0.00898	0.615	0.015
51	2.1794	3.5234	0.206	-1.3440	0.615	-2.185
52	3.5000	3.3031	0.211	0.1969	0.613	0.321
53	2.7839	3.0827	0.222	-0.2988	0.610	-0.490
54	3.4761	2.8623	0.236	0.6137	0.604	1.016
55	2.6926	2.6420	0.255	0.0506	0.596	0.085
56	4.1332	4.4490	0.298	-0.3159	0.576	-0.548
57	3.8945	4.2287	0.292	-0.3342	0.579	-0.577
58	4.1028	4.0083	0.290	0.0945	0.580	0.163
59	4.5497	3.7880	0.292	0.7617	0.579	1.315
60	3.3615	3.5676	0.298	-0.2061	0.576	-0.358

```
                              Cook's
Obs    -2-1-0 1 2                  D

  1  |        |        |       0.001
  2  |        |***     |       0.081
  3  |     ***|        |       0.084
  4  |        |**      |       0.028
  5  |      **|        |       0.035
  6  |       *|        |       0.017
  7  |        |        |       0.003
  8  |        |        |       0.002
  9  |        |*       |       0.004
 10  |      **|        |       0.025
 11  |       *|        |       0.009
 12  |        |        |       0.000
 13  |        |        |       0.000
 14  |        |*       |       0.009
 15  |        |****    |       0.086
 16  |        |***     |       0.109
 17  |        |        |       0.001
 18  |        |        |       0.001
 19  |        |        |       0.003
 20  |      **|        |       0.039
 21  |        |******  |       0.272
 22  |       *|        |       0.010
 23  |     ***|        |       0.080
 24  |       *|        |       0.008
 25  |        |        |       0.001
 26  |        |        |       0.004
 27  |        |        |       0.000
 28  |       *|        |       0.008
 29  |        |        |       0.000
 30  |        |        |       0.000
 31  |       *|        |       0.005
 32  |        |*       |       0.007
 33  |        |        |       0.001
 34  |        |        |       0.001
 35  |        |*       |       0.005
 36  |        |        |       0.002
 37  |        |        |       0.003
 38  |       *|        |       0.006
 39  |      **|        |       0.014
 40  |        |**      |       0.017
 41  |        |        |       0.001
 42  |       *|        |       0.003
 43  |        |*       |       0.009
 44  |        |        |       0.000
 45  |        |        |       0.000
 46  |        |*****   |       0.178
 47  |        |        |       0.002
 48  |      **|        |       0.017
```

```
         49  |     *|      |     0.009
         50  |      |      |     0.000
         51  |  ****|      |     0.067
         52  |      |      |     0.002
         53  |      |      |     0.004
         54  |      |**    |     0.020
         55  |      |      |     0.000
         56  |     *|      |     0.010
         57  |     *|      |     0.011
         58  |      |      |     0.001
         59  |      |**    |     0.055
         60  |      |      |     0.004

Sum of Residuals                      0
Sum of Squared Residuals        21.8701
Predicted Resid SS (Press)      30.3491
```

EXPERIMENT 1: GDSS VERSUS FACILITATED-MANUAL
TEST FOR NORMALITY OF RESIDUALS
RUN EXP1WRSD TRANSFORMED WITHOUT FACILITATOR

Univariate Procedure

Variable=RESIDUAL

Moments

N	60	Sum Wgts	60
Mean	5E-6	Sum	0.0003
Std Dev	0.617519	Variance	0.38133
Skewness	0.537531	Kurtosis	0.802214
USS	22.49846	CSS	22.49846
CV	12350381	Std Mean	0.079721
T:Mean=0	0.000063	Prob>|T|	1.0000
Num ^= 0	60	Num > 0	27
M(Sign)	-3	Prob>|M|	0.5190
Sgn Rank	-71.5	Prob>|S|	0.6028
W:Normal	0.966709	Prob<W	0.2191

Quantiles(Def=5)

100% Max	1.7119	99%	1.7119
75% Q3	0.2826	95%	1.21585
50% Med	-0.05565	90%	0.8826
25% Q1	-0.3988	10%	-0.68205
0% Min	-1.4658	5%	-0.9405
		1%	-1.4658
Range	3.1777		
Q3-Q1	0.6814		
Mode	-1.4658		

Extremes

Lowest	Obs	Highest	Obs
-1.4658(	51)	1.0961(	2)
-1.095(	23)	1.2067(	15)
-0.9829(	3)	1.225(	16)
-0.8981(	10)	1.5138(	46)
-0.7753(	39)	1.7119(	21)

Univariate Procedure

Variable=RESIDUAL

Moments

N	60	Sum Wgts	60
Mean	5E-6	Sum	0.0003
Std Dev	0.617519	Variance	0.38133
Skewness	0.537531	Kurtosis	0.802214
USS	22.49846	CSS	22.49846
CV	12350381	Std Mean	0.079721
T:Mean=0	0.000063	Prob>|T|	1.0000
Num ^= 0	60	Num > 0	27
M(Sign)	-3	Prob>|M|	0.5190
Sgn Rank	-71.5	Prob>|S|	0.6028

Quantiles(Def=5)

100% Max	1.7119	99%	1.7119
75% Q3	0.2826	95%	1.21585
50% Med	-0.05565	90%	0.8826
25% Q1	-0.3988	10%	-0.68205
0% Min	-1.4658	5%	-0.9405
		1%	-1.4658
Range	3.1777		
Q3-Q1	0.6814		
Mode	-1.4658		

Extremes

Lowest	Obs	Highest	Obs
-1.4658(	51)	1.0961(	2)
-1.095(	23)	1.2067(	15)
-0.9829(	3)	1.225(	16)
-0.8981(	10)	1.5138(	46)
-0.7753(	39)	1.7119(	21)

Univariate Procedure

Variable=RESIDUAL

```
Stem Leaf                     #             Boxplot
  16 1                        1                0
  14 1                        1                0
  12 12                       2                |
  10 20                       2                |
   8                                           |
   6 75                       2                |
   4 11617                    5                |
   2 3794                     4             +-----+
   0 4455681255              10             |  +  |
  -0 7321988766653           13             *-----*
  -2 99719                    5             |     |
  -4 8650531                  7             +-----+
  -6 8510                     4                |
  -8 80                       2                |
 -10 0                        1                |
 -12
 -14 7                        1                0
     ----+----+----+----+
 Multiply Stem.Leaf by 10**-1
```

```
                        Normal Probability Plot
  1.7+                                                        *
     |                                                    *  +++
     |                                                 ** +++
     |                                              ** +++
     |                                              ++++
     |                                           +**
     |                                        +****
     |                                     +++**
  0.1+                                 ++****
     |                             ******
     |                           **+
     |                      *****
     |                   ****+
     |                *****
     |              **+
     |           +++
 -1.5++++*
      +----+----+----+----+----+----+----+----+----+----+
          -2        -1         0        +1        +2
```

EXPERIMENT 1: GDSS VERSUS FACILITATED-MANUAL
TEST FOR NORMALITY OF RESIDUALS
RUN EXP1WFRD TRANSFORMED WITH FACILITATOR

Univariate Procedure

Variable=RESIDUAL

Moments

N	60	Sum Wgts	60
Mean	-2.33E-6	Sum	-0.00014
Std Dev	0.608834	Variance	0.370679
Skewness	0.726058	Kurtosis	1.180389
USS	21.87006	CSS	21.87006
CV	-2.609E7	Std Mean	0.0786
T:Mean=0	-0.00003	Prob>|T|	1.0000
Num ^= 0	60	Num > 0	27
M(Sign)	-3	Prob>|M|	0.5190
Sgn Rank	-89.5	Prob>|S|	0.5145
W:Normal	0.960295	Prob<W	0.1086

Quantiles(Def=5)

100% Max	1.7928	99%	1.7928
75% Q3	0.2848	95%	1.191
50% Med	-0.05565	90%	0.7842
25% Q1	-0.3502	10%	-0.662
0% Min	-1.344	5%	-0.9435
		1%	-1.344
Range	3.1368		
Q3-Q1	0.635		
Mode	-1.344		

Extremes

Lowest	Obs	Highest	Obs
-1.344(	51)	1.0336(	2)
-1.0515(	3)	1.1685(	16)
-1.0263(	23)	1.2135(	15)
-0.8607(	10)	1.6663(	46)
-0.7099(	39)	1.7928(	21)

Univariate Procedure

Variable=RESIDUAL

Moments

N	60	Sum Wgts	60
Mean	-2.33E-6	Sum	-0.00014
Std Dev	0.608834	Variance	0.370679
Skewness	0.726058	Kurtosis	1.180389
USS	21.87006	CSS	21.87006
CV	-2.609E7	Std Mean	0.0786
T:Mean=0	-0.00003	Prob>|T|	1.0000
Num ^= 0	60	Num > 0	27
M(Sign)	-3	Prob>|M|	0.5190
Sgn Rank	-89.5	Prob>|S|	0.5145

Quantiles(Def=5)

100% Max	1.7928	99%	1.7928
75% Q3	0.2848	95%	1.191
50% Med	-0.05565	90%	0.7842
25% Q1	-0.3502	10%	-0.662
0% Min	-1.344	5%	-0.9435
		1%	-1.344
Range	3.1368		
Q3-Q1	0.635		
Mode	-1.344		

Extremes

Lowest	Obs	Highest	Obs
-1.344(	51)	1.0336(	2)
-1.0515(	3)	1.1685(	16)
-1.0263(	23)	1.2135(	15)
-0.8607(	10)	1.6663(	46)
-0.7099(	39)	1.7928(	21)

Univariate Procedure

Variable=RESIDUAL

```
              Stem Leaf                     #             Boxplot
                16 79                       2                0
                14
                12 1                        1                |
                10 37                       2                |
                 8 1                        1                |
                 6 016                      3                |
                 4 301                      3                |
                 2 0007012                  7             +-----+
                 0 01577996                 8             |     |
                -0 552218410                9             *--+--*
                -2 6432204311              10             +-----+
                -4 229832                   6                |
                -6 1841                     4                |
                -8 6                        1                |
               -10 53                       2                |
               -12 4                        1                0
                   ----+----+----+----+
               Multiply Stem.Leaf by 10**-1


                          Normal Probability Plot
               1.7+                                                  *   *
                  |                                                     +++
                  |                                                *  +++
               1.1+                                              * ****
                  |                                             ++++
                  |                                           +++
               0.5+                                         +****
                  |                                       +****
                  |                                     *****
              -0.1+                                 +****
                  |                             *****
                  |                         ****+
              -0.7+                      ****+
                  |                    *++
                  |                 *+*
              -1.3+ *+**
                   +----+----+----+----+----+----+----+----+----+----+
                       -2        -1         0        +1        +2
```

EXPERIMENT 2: FACILITATED-MANUAL VERSUS MANUAL
REGRESSION ANALYSIS USING INDICATOR VARIABLES
WITH RESIDUAL PLOT

Model: MODEL1
Dependent Variable: TIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	2125.72031	354.28672	8.675	0.0001
Error	68	2777.01490	40.83845		
C Total	74	4902.73521			

Root MSE	6.39050	R-square	0.4336
Dep Mean	11.17332	Adj R-sq	0.3836
C.V.	57.19426		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	16.175133	2.19422853	7.372	0.0001
GROUP4	1	2.571193	2.99433408	0.859	0.3935
GROUP5	1	1.778550	2.25938195	0.787	0.4339
GROUP6	1	3.657350	2.25938195	1.619	0.1101
DAY	1	-1.433353	1.49716704	-0.957	0.3418
INTERVAL	1	-1.511237	0.25990831	-5.815	0.0001
FACILITY	1	3.778300	2.02085265	1.870	0.0658

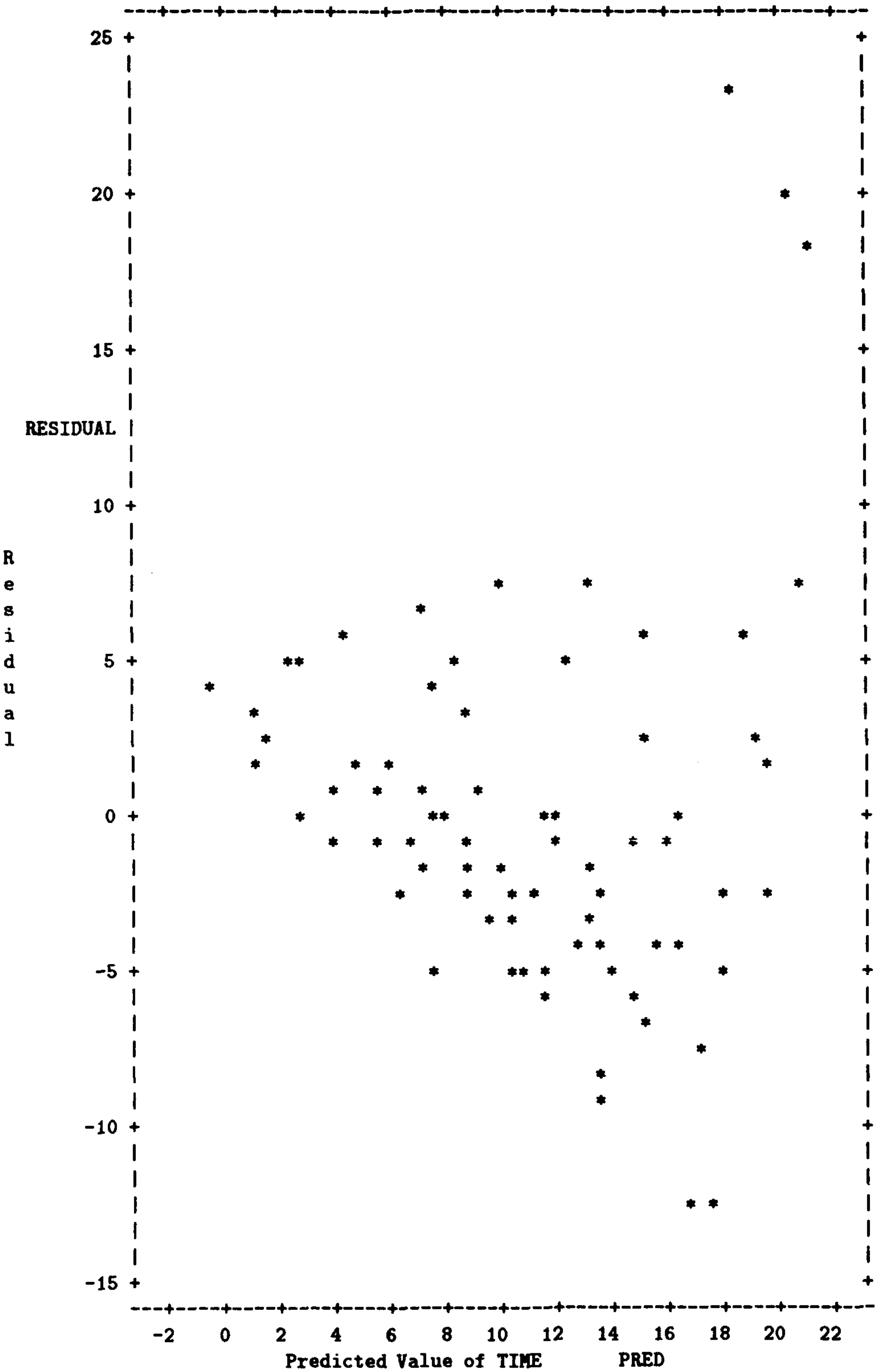
Variable	DF	Variance Inflation
INTERCEP	1	0.00000000
GROUP4	1	2.63458647
GROUP5	1	1.83333333
GROUP6	1	1.83333333
DAY	1	1.02456140
INTERVAL	1	1.02005013
FACILITY	1	1.86666667

Durbin-Watson D	1.961
(For Number of Obs.)	75
1st Order Autocorrelation	-0.046

Obs	Dep Var TIME	Predict Value	Residual
1	39.5830	21.0134	18.5696
2	21.1670	19.5022	1.6648
3	12.7500	17.9909	-5.2409
4	12.1670	16.4797	-4.3127
5	14.0830	14.9684	-0.8854
6	4.7500	13.4572	-8.7072
7	12.2500	11.9460	0.3040
8	7.7500	10.4347	-2.6847
9	12.0830	8.9235	3.1595
10	7.2500	7.4123	-0.1623
11	17.0830	19.5800	-2.4970
12	15.1670	18.0688	-2.9018
13	16.8330	16.5576	0.2754
14	20.7000	15.0463	5.6537
15	11.3000	13.5351	-2.2351
16	40.4160	20.2207	20.1953
17	24.8330	18.7095	6.1235
18	9.6670	17.1983	-7.5313
19	11.5000	15.6870	-4.1870
20	8.9500	14.1758	-5.2258
21	8.1600	12.6646	-4.5046
22	8.5000	11.1533	-2.6533
23	6.4160	9.6421	-3.2261
24	8.4160	8.1308	0.2852
25	5.5000	6.6196	-1.1196
26	8.0830	15.0091	-6.9261
27	9.6300	13.4979	-3.8679
28	10.9330	11.9866	-1.0536
29	5.0660	10.4754	-5.4094
30	8.2000	8.9641	-0.7641
31	11.7500	7.4529	4.2971
32	7.4500	5.9417	1.5083
33	10.4330	4.4304	6.0026
34	8.2170	2.9192	5.2978
35	4.1670	1.4080	2.7590
36	41.5000	18.3212	23.1788
37	4.5830	16.8100	-12.2270
38	17.4170	15.2988	2.1182
39	4.3670	13.7875	-9.4205
40	17.3830	12.2763	5.1067
41	5.5830	10.7651	-5.1821
42	9.9170	9.2538	0.6632
43	3.0000	7.7426	-4.7426
44	3.3300	6.2313	-2.9013
45	6.2830	4.7201	1.5629
46	28.0000	20.6662	7.3338
47	21.4170	19.1550	2.2620
48	4.7500	17.6437	-12.8937

49	15.6670	16.1325	-0.4655
50	8.8330	14.6212	-5.7882
51	20.5000	13.1100	7.3900
52	5.7500	11.5988	-5.8488
53	8.2500	10.0875	-1.8375
54	13.7500	8.5763	5.1737
55	13.5830	7.0651	6.5179
56	14.2330	14.6639	-0.4309
57	9.5000	13.1527	-3.6527
58	6.3330	11.6414	-5.3084
59	17.2500	10.1302	7.1198
60	5.8330	8.6189	-2.7859
61	7.8330	7.1077	0.7253
62	4.4170	5.5965	-1.1795
63	3.2500	4.0852	-0.8352
64	7.5000	2.5740	4.9260
65	4.4670	1.0628	3.4042
66	11.5000	13.2305	-1.7305
67	11.4170	11.7193	-0.3023
68	6.8330	10.2081	-3.3751
69	7.0830	8.6968	-1.6138
70	5.2500	7.1856	-1.9356
71	6.9170	5.6744	1.2426
72	4.5830	4.1631	0.4199
73	2.7170	2.6519	0.0651
74	2.4500	1.1406	1.3094
75	3.5670	-0.3706	3.9376

Sum of Residuals	0
Sum of Squared Residuals	2777.0149
Predicted Resid SS (Press)	3482.4609


RESIDUAL
Residual
25
20
15
10
5
0
-5
-10
-15
-2
0
2
4
6
8
10
12
14
16
18
20
22
Predicted Value of TIME PRED

Obs	Dep Var TIME	Predict Value	Std Err Predict	Residual	Std Err Residual	Student Residual
1	39.5830	21.0134	1.989	18.5696	6.073	3.058
2	21.1670	19.5022	1.873	1.6648	6.110	0.272
3	12.7500	17.9909	1.787	-5.2409	6.136	-0.854
4	12.1670	16.4797	1.736	-4.3127	6.150	-0.701
5	14.0830	14.9684	1.724	-0.8854	6.154	-0.144
6	4.7500	13.4572	1.751	-8.7072	6.146	-1.417
7	12.2500	11.9460	1.814	0.3040	6.128	0.050
8	7.7500	10.4347	1.912	-2.6847	6.098	-0.440
9	12.0830	8.9235	2.037	3.1595	6.057	0.522
10	7.2500	7.4123	2.187	-0.1623	6.005	-0.027
11	17.0830	19.5800	2.116	-2.4970	6.030	-0.414
12	15.1670	18.0688	2.022	-2.9018	6.062	-0.479
13	16.8330	16.5576	1.959	0.2754	6.083	0.045
14	20.7000	15.0463	1.929	5.6537	6.092	0.928
15	11.3000	13.5351	1.934	-2.2351	6.091	-0.367
16	40.4160	20.2207	2.265	20.1953	5.976	3.380
17	24.8330	18.7095	2.135	6.1235	6.023	1.017
18	9.6670	17.1983	2.030	-7.5313	6.059	-1.243
19	11.5000	15.6870	1.955	-4.1870	6.084	-0.688
20	8.9500	14.1758	1.912	-5.2258	6.098	-0.857
21	8.1600	12.6646	1.904	-4.5046	6.100	-0.738
22	8.5000	11.1533	1.931	-2.6533	6.092	-0.436
23	6.4160	9.6421	1.992	-3.2261	6.072	-0.531
24	8.4160	8.1308	2.084	0.2852	6.041	0.047
25	5.5000	6.6196	2.203	-1.1196	5.999	-0.187
26	8.0830	15.0091	2.203	-6.9261	5.999	-1.155
27	9.6300	13.4979	2.084	-3.8679	6.041	-0.640
28	10.9330	11.9866	1.992	-1.0536	6.072	-0.174
29	5.0660	10.4754	1.931	-5.4094	6.092	-0.888
30	8.2000	8.9641	1.904	-0.7641	6.100	-0.125
31	11.7500	7.4529	1.912	4.2971	6.098	0.705
32	7.4500	5.9417	1.955	1.5083	6.084	0.248
33	10.4330	4.4304	2.030	6.0026	6.059	0.991
34	8.2170	2.9192	2.135	5.2978	6.023	0.880
35	4.1670	1.4080	2.265	2.7590	5.976	0.462
36	41.5000	18.3212	2.265	23.1788	5.976	3.879
37	4.5830	16.8100	2.135	-12.2270	6.023	-2.030
38	17.4170	15.2988	2.030	2.1182	6.059	0.350
39	4.3670	13.7875	1.955	-9.4205	6.084	-1.548
40	17.3830	12.2763	1.912	5.1067	6.098	0.837
41	5.5830	10.7651	1.904	-5.1821	6.100	-0.849
42	9.9170	9.2538	1.931	0.6632	6.092	0.109
43	3.0000	7.7426	1.992	-4.7426	6.072	-0.781
44	3.3300	6.2313	2.084	-2.9013	6.041	-0.480
45	6.2830	4.7201	2.203	1.5629	5.999	0.261
46	28.0000	20.6662	2.203	7.3338	5.999	1.223
47	21.4170	19.1550	2.084	2.2620	6.041	0.374
48	4.7500	17.6437	1.992	-12.8937	6.072	-2.123

49	15.6670	16.1325	1.931	-0.4655	6.092	-0.076
50	8.8330	14.6212	1.904	-5.7882	6.100	-0.949
51	20.5000	13.1100	1.912	7.3900	6.098	1.212
52	5.7500	11.5988	1.955	-5.8488	6.084	-0.961
53	8.2500	10.0875	2.030	-1.8375	6.059	-0.303
54	13.7500	8.5763	2.135	5.1737	6.023	0.859
55	13.5830	7.0651	2.265	6.5179	5.976	1.091
56	14.2330	14.6639	2.027	-0.4309	6.061	-0.071
57	9.5000	13.1527	1.881	-3.6527	6.107	-0.598
58	6.3330	11.6414	1.761	-5.3084	6.143	-0.864
59	17.2500	10.1302	1.673	7.1198	6.168	1.154
60	5.8330	8.6189	1.623	-2.7859	6.181	-0.451
61	7.8330	7.1077	1.614	0.7253	6.183	0.117
62	4.4170	5.5965	1.646	-1.1795	6.175	-0.191
63	3.2500	4.0852	1.717	-0.8352	6.156	-0.136
64	7.5000	2.5740	1.823	4.9260	6.125	0.804
65	4.4670	1.0628	1.958	3.4042	6.083	0.560
66	11.5000	13.2305	1.958	-1.7305	6.083	-0.284
67	11.4170	11.7193	1.823	-0.3023	6.125	-0.049
68	6.8330	10.2081	1.717	-3.3751	6.156	-0.548
69	7.0830	8.6968	1.646	-1.6138	6.175	-0.261
70	5.2500	7.1856	1.614	-1.9356	6.183	-0.313
71	6.9170	5.6744	1.623	1.2426	6.181	0.201
72	4.5830	4.1631	1.673	0.4199	6.168	0.068
73	2.7170	2.6519	1.761	0.0651	6.143	0.011
74	2.4500	1.1406	1.881	1.3094	6.107	0.214
75	3.5670	-0.3706	2.027	3.9376	6.061	0.650

```
                            Cook's
Obs    -2-1-0 1 2              D

  1   |      |******|      0.143
  2   |      |      |      0.001
  3   |     *|      |      0.009
  4   |     *|      |      0.006
  5   |      |      |      0.000
  6   |    **|      |      0.023
  7   |      |      |      0.000
  8   |      |      |      0.003
  9   |      |*     |      0.004
 10   |      |      |      0.000
 11   |      |      |      0.003
 12   |      |      |      0.004
 13   |      |      |      0.000
 14   |      |*     |      0.012
 15   |      |      |      0.002
 16   |      |******|      0.234
 17   |      |**    |      0.019
 18   |    **|      |      0.025
 19   |     *|      |      0.007
 20   |     *|      |      0.010
 21   |     *|      |      0.008
 22   |      |      |      0.003
 23   |     *|      |      0.004
 24   |      |      |      0.000
 25   |      |      |      0.001
 26   |    **|      |      0.026
 27   |     *|      |      0.007
 28   |      |      |      0.000
 29   |     *|      |      0.011
 30   |      |      |      0.000
 31   |      |*     |      0.007
 32   |      |      |      0.001
 33   |      |*     |      0.016
 34   |      |*     |      0.014
 35   |      |      |      0.004
 36   |      |******|      0.309
 37   |  ****|      |      0.074
 38   |      |      |      0.002
 39   |   ***|      |      0.035
 40   |      |*     |      0.010
 41   |     *|      |      0.010
 42   |      |      |      0.000
 43   |     *|      |      0.009
 44   |      |      |      0.004
 45   |      |      |      0.001
 46   |      |**    |      0.029
 47   |      |      |      0.002
 48   |  ****|      |      0.069
```

```
49  |       |       |   0.000
50  |      *|       |   0.013
51  |       |**     |   0.021
52  |      *|       |   0.014
53  |       |       |   0.001
54  |       |*      |   0.013
55  |       |**     |   0.024
56  |       |       |   0.000
57  |      *|       |   0.005
58  |      *|       |   0.009
59  |       |**     |   0.014
60  |       |       |   0.002
61  |       |       |   0.000
62  |       |       |   0.000
63  |       |       |   0.000
64  |       |*      |   0.008
65  |       |*      |   0.005
66  |       |       |   0.001
67  |       |       |   0.000
68  |      *|       |   0.003
69  |       |       |   0.001
70  |       |       |   0.001
71  |       |       |   0.000
72  |       |       |   0.000
73  |       |       |   0.000
74  |       |       |   0.001
75  |       |*      |   0.007

Sum of Residuals                     0
Sum of Squared Residuals     2777.0149
Predicted Resid SS (Press)   3482.4609
```

EXPERIMENT 2: FACILITATED-MANUAL VERSUS MANUAL
TEST FOR NORMALITY OF RESIDUALS
RUN EXP2ARSD

Univariate Procedure

Variable=RESIDUAL

Moments

N	75	Sum Wgts	75
Mean	-1.33E-6	Sum	-0.0001
Std Dev	6.125949	Variance	37.52725
Skewness	1.323592	Kurtosis	3.841498
USS	2777.017	CSS	2777.017
CV	-4.594E8	Std Mean	0.707364
T:Mean=0	-1.88E-6	Prob>|T|	1.0000
Num ^= 0	75	Num > 0	33
M(Sign)	-4.5	Prob>|M|	0.3557
Sgn Rank	-159	Prob>|S|	0.4048
W:Normal	0.907471	Prob<W	0.0001

Quantiles(Def=5)

100% Max	23.1788	99%	23.1788
75% Q3	2.759	95%	7.39
50% Med	-0.7641	90%	6.1235
25% Q1	-3.6527	10%	-5.7882
0% Min	-12.8937	5%	-8.7072
		1%	-12.8937
Range	36.0725		
Q3-Q1	6.4117		
Mode	-12.8937		

Extremes

Lowest	Obs	Highest	Obs
-12.8937(	48)	7.3338(	46)
-12.227(	37)	7.39(	51)
-9.4205(	39)	18.5696(	1)
-8.7072(	6)	20.1953(	16)
-7.5313(	18)	23.1788(	36)

Univariate Procedure

Variable=RESIDUAL

Moments

N	75	Sum Wgts	75
Mean	-1.33E-6	Sum	-0.0001
Std Dev	6.125949	Variance	37.52725
Skewness	1.323592	Kurtosis	3.841498
USS	2777.017	CSS	2777.017
CV	-4.594E8	Std Mean	0.707364
T:Mean=0	-1.88E-6	Prob>|T|	1.0000
Num ^= 0	75	Num > 0	33
M(Sign)	-4.5	Prob>|M|	0.3557
Sgn Rank	-159	Prob>|S|	0.4048

Quantiles(Def=5)

100% Max	23.1788	99%	23.1788
75% Q3	2.759	95%	7.39
50% Med	-0.7641	90%	6.1235
25% Q1	-3.6527	10%	-5.7882
0% Min	-12.8937	5%	-8.7072
		1%	-12.8937
Range	36.0725		
Q3-Q1	6.4117		
Mode	-12.8937		

Extremes

Lowest	Obs	Highest	Obs
-12.8937(	48)	7.3338(	46)
-12.227(	37)	7.39(	51)
-9.4205(	39)	18.5696(	1)
-8.7072(	6)	20.1953(	16)
-7.5313(	18)	23.1788(	36)

Univariate Procedure

Variable=RESIDUAL

```
Stem Leaf                        #             Boxplot
  22 2                           1                *
  20 2                           1                0
  18 6                           1                0
  16
  14
  12
  10
   8
   6 015134                      6                |
   4 391237                      6                |
   2 138249                      6             +-----+
   0 133347723567               12             |     |
  -0 98762119885432             14             *--+--*
  -2 97429987752                11             +-----+
  -4 88432227532                11                |
  -6 59                          2                |
  -8 47                          2                |
 -10                                              |
 -12 92                          2                |
     ----+----+----+----+
```

```
                    Normal Probability Plot
 23+                                                   *
   |                                               *
   |                                             *
   |
   |                                                 +++
   |                                              +++
   |                                           +++
   |                                        +++
   |                                    ++++++ *
  5+                                 +++++
   |                              +++++
   |                           ++++++
   |                       *****
   |                   *****
   |            ********+
   |           ******
   |        *****
   |       +++
-13+ * +++
   +----+----+----+----+----+----+----+----+----+----+
       -2        -1         0        +1        +2
```

EXPERIMENT 2: FACILITATED-MANUAL VERSUS MANUAL
REGRESSION ANALYSIS USING INDICATOR VARIABLES
WITH RESIDUAL PLOT AND TIME TRANSFORMED USING (TIME)^(.5)

Model: MODEL1
Dependent Variable: TIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	40.57535	6.76256	10.807	0.0001
Error	68	42.55160	0.62576		
C Total	74	83.12695			

Root MSE	0.79105	R-square	0.4881
Dep Mean	3.17253	Adj R-sq	0.4429
C.V.	24.93431		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.755417	0.27161308	13.826	0.0001
GROUP4	1	0.417847	0.37065433	1.127	0.2636
GROUP5	1	0.283274	0.27967811	1.013	0.3147
GROUP6	1	0.471522	0.27967811	1.686	0.0964
DAY	1	-0.115886	0.18532716	-0.625	0.5339
INTERVAL	1	-0.202222	0.03217281	-6.286	0.0001
FACILITY	1	0.567571	0.25015171	2.269	0.0265

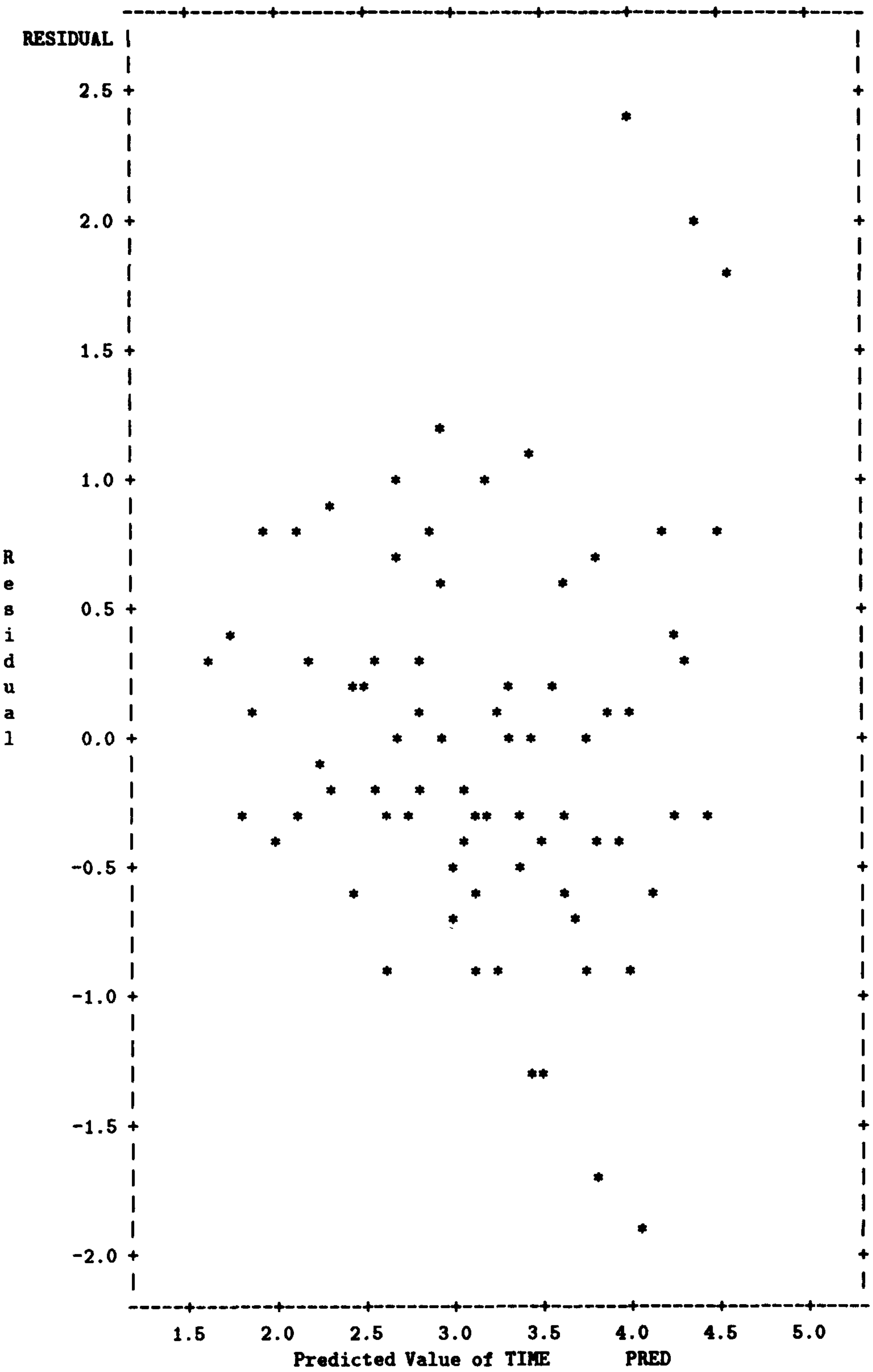
Variable	DF	Variance Inflation
INTERCEP	1	0.00000000
GROUP4	1	2.63458647
GROUP5	1	1.83333333
GROUP6	1	1.83333333
DAY	1	1.02456140
INTERVAL	1	1.02005013
FACILITY	1	1.86666667

Durbin-Watson D	2.219
(For Number of Obs.)	75
1st Order Autocorrelation	-0.146

Obs	Dep Var TIME	Predict Value	Residual
1	6.2915	4.5386	1.7529
2	4.6008	4.3364	0.2644
3	3.5707	4.1342	-0.5635
4	3.4881	3.9319	-0.4438
5	3.7527	3.7297	0.0230
6	2.1794	3.5275	-1.3481
7	3.5000	3.3253	0.1747
8	2.7839	3.1231	-0.3392
9	3.4761	2.9208	0.5552
10	2.6926	2.7186	-0.0260
11	4.1332	4.4227	-0.2896
12	3.8945	4.2205	-0.3260
13	4.1028	4.0183	0.0845
14	4.5497	3.8161	0.7337
15	3.3615	3.6138	-0.2523
16	6.3574	4.4040	1.9533
17	4.9833	4.2018	0.7815
18	3.1092	3.9996	-0.8904
19	3.3912	3.7974	-0.4062
20	2.9917	3.5952	-0.6035
21	2.8566	3.3929	-0.5364
22	2.9155	3.1907	-0.2752
23	2.5330	2.9885	-0.4555
24	2.9010	2.7863	0.1148
25	2.3452	2.5840	-0.2388
26	2.8431	3.7206	-0.8775
27	3.1032	3.5184	-0.4151
28	3.3065	3.3161	-0.00963
29	2.2508	3.1139	-0.8631
30	2.8636	2.9117	-0.0481
31	3.4278	2.7095	0.7184
32	2.7295	2.5072	0.2222
33	3.2300	2.3050	0.9250
34	2.8665	2.1028	0.7637
35	2.0413	1.9006	0.1407
36	6.4420	4.0247	2.4173
37	2.1408	3.8225	-1.6817
38	4.1734	3.6203	0.5531
39	2.0897	3.4180	-1.3283
40	4.1693	3.2158	0.9535
41	2.3628	3.0136	-0.6508
42	3.1491	2.8114	0.3377
43	1.7321	2.6092	-0.8771
44	1.8248	2.4069	-0.5821
45	2.5066	2.2047	0.3019
46	5.2915	4.4764	0.8151
47	4.6279	4.2742	0.3537
48	2.1794	4.0720	-1.8925

49	3.9582	3.8697	0.0884
50	2.9720	3.6675	-0.6955
51	4.5277	3.4653	1.0624
52	2.3979	3.2631	-0.8652
53	2.8723	3.0608	-0.1886
54	3.7081	2.8586	0.8495
55	3.6855	2.6564	1.0291
56	3.7727	3.5532	0.2195
57	3.0822	3.3510	-0.2688
58	2.5165	3.1487	-0.6322
59	4.1533	2.9465	1.2068
60	2.4152	2.7443	-0.3291
61	2.7987	2.5421	0.2567
62	2.1017	2.3399	-0.2382
63	1.8028	2.1376	-0.3349
64	2.7386	1.9354	0.8032
65	2.1135	1.7332	0.3803
66	3.3912	3.4373	-0.0461
67	3.3789	3.2351	0.1438
68	2.6140	3.0329	-0.4189
69	2.6614	2.8306	-0.1693
70	2.2913	2.6284	-0.3371
71	2.6300	2.4262	0.2038
72	2.1408	2.2240	-0.0832
73	1.6483	2.0218	-0.3734
74	1.5652	1.8195	-0.2543
75	1.8887	1.6173	0.2713

Sum of Residuals	0
Sum of Squared Residuals	42.5516
Predicted Resid SS (Press)	52.9027


RESIDUAL
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Residual
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Value of TIME PRED

Obs	Dep Var TIME	Predict Value	Std Err Predict	Residual	Std Err Residual	Student Residual
1	6.2915	4.5386	0.246	1.7529	0.752	2.332
2	4.6008	4.3364	0.232	0.2644	0.756	0.350
3	3.5707	4.1342	0.221	-0.5635	0.759	-0.742
4	3.4881	3.9319	0.215	-0.4438	0.761	-0.583
5	3.7527	3.7297	0.213	0.0230	0.762	0.030
6	2.1794	3.5275	0.217	-1.3481	0.761	-1.772
7	3.5000	3.3253	0.225	0.1747	0.758	0.230
8	2.7839	3.1231	0.237	-0.3392	0.755	-0.449
9	3.4761	2.9208	0.252	0.5552	0.750	0.741
10	2.6926	2.7186	0.271	-0.0260	0.743	-0.035
11	4.1332	4.4227	0.262	-0.2896	0.746	-0.388
12	3.8945	4.2205	0.250	-0.3260	0.750	-0.434
13	4.1028	4.0183	0.243	0.0845	0.753	0.112
14	4.5497	3.8161	0.239	0.7337	0.754	0.973
15	3.3615	3.6138	0.239	-0.2523	0.754	-0.335
16	6.3574	4.4040	0.280	1.9533	0.740	2.641
17	4.9833	4.2018	0.264	0.7815	0.746	1.048
18	3.1092	3.9996	0.251	-0.8904	0.750	-1.187
19	3.3912	3.7974	0.242	-0.4062	0.753	-0.539
20	2.9917	3.5952	0.237	-0.6035	0.755	-0.800
21	2.8566	3.3929	0.236	-0.5364	0.755	-0.710
22	2.9155	3.1907	0.239	-0.2752	0.754	-0.365
23	2.5330	2.9885	0.247	-0.4555	0.752	-0.606
24	2.9010	2.7863	0.258	0.1148	0.748	0.153
25	2.3452	2.5840	0.273	-0.2388	0.743	-0.322
26	2.8431	3.7206	0.273	-0.8775	0.743	-1.182
27	3.1032	3.5184	0.258	-0.4151	0.748	-0.555
28	3.3065	3.3161	0.247	-0.00963	0.752	-0.013
29	2.2508	3.1139	0.239	-0.8631	0.754	-1.145
30	2.8636	2.9117	0.236	-0.0481	0.755	-0.064
31	3.4278	2.7095	0.237	0.7184	0.755	0.952
32	2.7295	2.5072	0.242	0.2222	0.753	0.295
33	3.2300	2.3050	0.251	0.9250	0.750	1.233
34	2.8665	2.1028	0.264	0.7637	0.746	1.024
35	2.0413	1.9006	0.280	0.1407	0.740	0.190
36	6.4420	4.0247	0.280	2.4173	0.740	3.268
37	2.1408	3.8225	0.264	-1.6817	0.746	-2.256
38	4.1734	3.6203	0.251	0.5531	0.750	0.737
39	2.0897	3.4180	0.242	-1.3283	0.753	-1.764
40	4.1693	3.2158	0.237	0.9535	0.755	1.263
41	2.3628	3.0136	0.236	-0.6508	0.755	-0.862
42	3.1491	2.8114	0.239	0.3377	0.754	0.448
43	1.7321	2.6092	0.247	-0.8771	0.752	-1.167
44	1.8248	2.4069	0.258	-0.5821	0.748	-0.778
45	2.5066	2.2047	0.273	0.3019	0.743	0.407
46	5.2915	4.4764	0.273	0.8151	0.743	1.098
47	4.6279	4.2742	0.258	0.3537	0.748	0.473
48	2.1794	4.0720	0.247	-1.8925	0.752	-2.518

49	3.9582	3.8697	0.239	0.0884	0.754	0.117
50	2.9720	3.6675	0.236	-0.6955	0.755	-0.921
51	4.5277	3.4653	0.237	1.0624	0.755	1.408
52	2.3979	3.2631	0.242	-0.8652	0.753	-1.149
53	2.8723	3.0608	0.251	-0.1886	0.750	-0.251
54	3.7081	2.8586	0.264	0.8495	0.746	1.139
55	3.6855	2.6564	0.280	1.0291	0.740	1.391
56	3.7727	3.5532	0.251	0.2195	0.750	0.293
57	3.0822	3.3510	0.233	-0.2688	0.756	-0.356
58	2.5165	3.1487	0.218	-0.6322	0.760	-0.831
59	4.1533	2.9465	0.207	1.2068	0.763	1.581
60	2.4152	2.7443	0.201	-0.3291	0.765	-0.430
61	2.7987	2.5421	0.200	0.2567	0.765	0.335
62	2.1017	2.3399	0.204	-0.2382	0.764	-0.312
63	1.8028	2.1376	0.213	-0.3349	0.762	-0.439
64	2.7386	1.9354	0.226	0.8032	0.758	1.059
65	2.1135	1.7332	0.242	0.3803	0.753	0.505
66	3.3912	3.4373	0.242	-0.0461	0.753	-0.061
67	3.3789	3.2351	0.226	0.1438	0.758	0.190
68	2.6140	3.0329	0.213	-0.4189	0.762	-0.550
69	2.6614	2.8306	0.204	-0.1693	0.764	-0.221
70	2.2913	2.6284	0.200	-0.3371	0.765	-0.440
71	2.6300	2.4262	0.201	0.2038	0.765	0.266
72	2.1408	2.2240	0.207	-0.0832	0.763	-0.109
73	1.6483	2.0218	0.218	-0.3734	0.760	-0.491
74	1.5652	1.8195	0.233	-0.2543	0.756	-0.336
75	1.8887	1.6173	0.251	0.2713	0.750	0.362

```
                          Cook's
Obs   -2-1-0 1 2             D

  1 |      |****  |      0.083
  2 |      |      |      0.002
  3 |     *|      |      0.007
  4 |     *|      |      0.004
  5 |      |      |      0.000
  6 |   ***|      |      0.036
  7 |      |      |      0.001
  8 |      |      |      0.003
  9 |      |*     |      0.009
 10 |      |      |      0.000
 11 |      |      |      0.003
 12 |      |      |      0.003
 13 |      |      |      0.000
 14 |      |*     |      0.014
 15 |      |      |      0.002
 16 |      |***** |      0.143
 17 |      |**    |      0.020
 18 |    **|      |      0.023
 19 |     *|      |      0.004
 20 |     *|      |      0.009
 21 |     *|      |      0.007
 22 |      |      |      0.002
 23 |     *|      |      0.006
 24 |      |      |      0.000
 25 |      |      |      0.002
 26 |    **|      |      0.027
 27 |     *|      |      0.005
 28 |      |      |      0.000
 29 |    **|      |      0.019
 30 |      |      |      0.000
 31 |      |*     |      0.013
 32 |      |      |      0.001
 33 |      |**    |      0.024
 34 |      |**    |      0.019
 35 |      |      |      0.001
 36 |      |******|      0.219
 37 |  ****|      |      0.091
 38 |      |*     |      0.009
 39 |   ***|      |      0.046
 40 |      |**    |      0.022
 41 |     *|      |      0.010
 42 |      |      |      0.003
 43 |    **|      |      0.021
 44 |     *|      |      0.010
 45 |      |      |      0.003
 46 |      |**    |      0.023
 47 |      |      |      0.004
 48 | *****|      |      0.097
```

```
49 |       |       |   0.000
50 |      *|       |   0.012
51 |       |**     |   0.028
52 |     **|       |   0.019
53 |       |       |   0.001
54 |       |**     |   0.023
55 |       |**     |   0.040
56 |       |       |   0.001
57 |       |       |   0.002
58 |      *|       |   0.008
59 |       |***    |   0.026
60 |       |       |   0.002
61 |       |       |   0.001
62 |       |       |   0.001
63 |       |       |   0.002
64 |       |**     |   0.014
65 |       |*      |   0.004
66 |       |       |   0.000
67 |       |       |   0.000
68 |      *|       |   0.003
69 |       |       |   0.000
70 |       |       |   0.002
71 |       |       |   0.001
72 |       |       |   0.000
73 |       |       |   0.003
74 |       |       |   0.002
75 |       |       |   0.002

Sum of Residuals                    0
Sum of Squared Residuals      42.5516
Predicted Resid SS (Press)    52.9027
```

EXPERIMENT 2: FACILITATED-MANUAL VERSUS MANUAL
TEST FOR NORMALITY OF RESIDUALS
RUN EXP2WRSD TRANSFORMED

Univariate Procedure

Variable=RESIDUAL

Moments

N	75	Sum Wgts	75
Mean	-1.73E-6	Sum	-0.00013
Std Dev	0.758303	Variance	0.575024
Skewness	0.464149	Kurtosis	1.244352
USS	42.55177	CSS	42.55177
CV	-4.375E7	Std Mean	0.087561
T:Mean=0	-0.00002	Prob>|T|	1.0000
Num ^= 0	75	Num > 0	34
M(Sign)	-3.5	Prob>|M|	0.4887
Sgn Rank	-89	Prob>|S|	0.6415
W:Normal	0.973672	Prob<W	0.3413

Quantiles(Def=5)

100% Max	2.4173	99%	2.4173
75% Q3	0.3537	95%	1.2068
50% Med	-0.0481	90%	0.925
25% Q1	-0.4189	10%	-0.8652
0% Min	-1.8925	5%	-1.3283
		1%	-1.8925
Range	4.3098		
Q3-Q1	0.7726		
Mode	-1.8925		

Extremes

Lowest	Obs	Highest	Obs
-1.8925(	48)	1.0624(	51)
-1.6817(	37)	1.2068(	59)
-1.3481(	6)	1.7529(	1)
-1.3283(	39)	1.9533(	16)
-0.8904(	18)	2.4173(	36)

Univariate Procedure

Variable=RESIDUAL

Moments

N	75	Sum Wgts	75
Mean	-1.73E-6	Sum	-0.00013
Std Dev	0.758303	Variance	0.575024
Skewness	0.464149	Kurtosis	1.244352
USS	42.55177	CSS	42.55177
CV	-4.375E7	Std Mean	0.087561
T:Mean=0	-0.00002	Prob>|T|	1.0000
Num ^= 0	75	Num > 0	34
M(Sign)	-3.5	Prob>|M|	0.4887
Sgn Rank	-89	Prob>|S|	0.6415

Quantiles(Def=5)

100% Max	2.4173	99%	2.4173
75% Q3	0.3537	95%	1.2068
50% Med	-0.0481	90%	0.925
25% Q1	-0.4189	10%	-0.8652
0% Min	-1.8925	5%	-1.3283
		1%	-1.8925
Range	4.3098		
Q3-Q1	0.7726		
Mode	-1.8925		

Extremes

Lowest	Obs	Highest	Obs
-1.8925(	48)	1.0624(	51)
-1.6817(	37)	1.2068(	59)
-1.3481(	6)	1.7529(	1)
-1.3283(	39)	1.9533(	16)
-0.8904(	18)	2.4173(	36)

Univariate Procedure

Variable=RESIDUAL

```
Stem Leaf                     #          Boxplot
  24 2                        1             0
  22
  20
  18 5                        1             0
  16 5                        1             0
  14
  12 1                        1             |
  10 36                       2             |
   8 02525                    5             |
   6 2368                     4             |
   4 56                       2             |
   2 0226670458              10          +-----+
   0 2891447                  7          |     |
  -0 9785531                  7          *--+--*
  -2 7443339875544           13          |     |
  -4 86464221                 8          +-----+
  -6 0530                     4             |
  -8 98876                    5             |
 -10                                        |
 -12 53                       2             |
 -14
 -16 8                        1             0
 -18 9                        1             0
     ----+----+----+----+
 Multiply Stem.Leaf by 10**-1
```

Univariate Procedure

Variable=RESIDUAL

Normal Probability Plot

```
 2.5+                                                 *
    |
    |
    |                                            *   ++
    |                                          *   ++
    |                                           +++
    |                                        +*+
    |                                      **
    |                                   ****
    |                                +**
    |                              +++
 0.3+                           +****
    |                         ***
    |                      +***
    |                  ******
    |               ****
    |             ***+
    |          ****+
    |          ++
    |       **+
    |    +++
    |  ++ *
-1.9++*
     +----+----+----+----+----+----+----+----+----+----+
         -2        -1         0        +1        +2
```

Appendix G. Consensus Data

GROUP: 1 DAY: 1 FACILITATOR: GR CAREER FIELD: Materials Engineer

TASK NUMBER

TRAINING LEVEL	1			2			3			4			5			6			7			8			9			10		
1	2			1			2															1	1	1	1	1				
2	1	5					3	5		1									1			4	4	4	3	4	5	3	5	
3	1									2	1	1	2			3	5		2	4	4				1			2		
4	1			3	5					1	3	4	2	4	5	1			1	1	1									
5				1						1	1		1	1		1			1											

INTERVAL TIME:
32.000

TASK NUMBER

TRAINING LEVEL	11			12			13			14			15			16			17			18			19			20		
1	2	3	3	3	4	4	2	1		1									1									3	2	2
2	3	2	2	2	1	1	3	4	5	1	1	1				2	2	2	4	5		1			4	3	3	1	2	2
3										1	4	4				3	3	3				3	1					1	1	1
4										2			2										3	4		1	2			
5													3	5								1	1	1	1	1				

INTERVAL TIME:
40.667

TASK NUMBER

TRAINING LEVEL	21			22			23			24			25			26			27			28			29			30		
1	3	4	5	4	5		1			5									5						5					
2	2	1		1			2	3	3																					
3							2	2	2				3	1	1	2														
4														1	1	1						3	2	2				3		
5													2	3	3	1	5					2	3	3				2	5	

INTERVAL TIME:
16.580

TASK NUMBER

TRAINING LEVEL	31			32			33			34			35			36			37			38			39			40		
1	1						1						2	3	3	2	3	2	1	1		1						1	1	1
2	2	3	5				3	4	5	3	4	4	3	2	2	3	2	3	3	4	5	3	2	3	2	4	5	2	3	4
3	2	2		2			1	1		1	1	1							1			1	3	2	1	1				
4				1	3	4				1																		1	1	
5				2	2	1																			2			1		

INTERVAL TIME:
30.250

TASK NUMBER

TRAINING LEVEL	41			42			43			44			45			46			47			48			49			50		
1																														
2	2	4	5	2	3	5	3	5		2						4	4	4	1			1						1		
3	2	1		3	2		2			2	5		2	1		1	1	1	2			2	4	5	4	5		3	5	
4	1									1			2	4	5				1	4	5	2	1		1			1		
5													1						1	1										

INTERVAL TIME:
16.333

Figure G.1. Consensus Recordings for Group 1, Day 1, Career Field 1.

GROUP: 1 DAY: 2 FACILITATOR: SH CAREER FIELD: Manufacturing Engineer

TRAINING LEVEL / TASK NUMBER

LEVEL		1			2			3			4			5			6			7			8			9			10	
1																														
2	5						4															1			3			2		
3				2			1	5								4	5					4	5		2	1		3	5	
4		5		3	5					5						1			1							4	5			
5													5						4	5										

INTERVAL TIME:
12.667

TRAINING LEVEL / TASK NUMBER

LEVEL		11			12			13			14			15			16			17			18			19			20	
1	3	1																												
2	2	4	5				5												3									5		
3				2						2	1	1	2	5		5			2	5					2	2	2			
4				3	5					3	4	4	3									5			3	3	3			
5																														

INTERVAL TIME:
13.100

TRAINING LEVEL / TASK NUMBER

LEVEL		21			22			23			24			25			26			27			28			29			30	
1	1			1						2	1								5						1					
2	4	5		1			3			1	3	5													4	5				
3				1			2	5		2	1					1														
4				2	4											1	1											3	3	3
5					1	5							5			3	4	5				5						2	2	2

INTERVAL TIME:
14.750

TRAINING LEVEL / TASK NUMBER

LEVEL		31			32			33			34			35			36			37			38			39			40	
1													4	1																
2							4	1					1	4	5	5			5			5			5			3		
3	4	1					1	4	5	3	5																	1	5	
4	1	4	5	3	2	2				2																		1		
5				2	3	3																								

INTERVAL TIME:
13.930

TRAINING LEVEL / TASK NUMBER

LEVEL		41			42			43			44			45			46			47			48			49			50	
1																														
2				5			2									5														
3	2						2	1					1						1			5			5			5		
4	3	5					1	4	5	5			3	5					4	5										
5													1																	

INTERVAL TIME:
5.460

Figure G.2. Consensus Recordings for Group 1, Day 2, Career Field 3.

GROUP: 1 **DAY:** 2 **FACILITATOR:** SH **CAREER FIELD:** Toxicologist

TRAINING LEVEL	TASK NUMBER 1	2	3	4	5	6	7	8	9	10
1										
2	4 5		1	2			5		4 5	1
3	1		4 5	3 5	5	1		5	1	3 5
4		5				2				1
5						2 5				

INTERVAL TIME:
6.033

TRAINING LEVEL	TASK NUMBER 11	12	13	14	15	16	17	18	19	20
1	2	3 5								1 5
2	3 5	2			1					1
3			1	5	2 5	1		2	5	3
4			1		2		1	3 5		
5			3 5			4 5	4 5			

INTERVAL TIME:
7.550

TRAINING LEVEL	TASK NUMBER 21	22	23	24	25	26	27	28	29	30
1		5		4 5		2			5	
2	2		4 5	1		2 5				3 5
3			1			1	1			1
4	3 5				1		2			1
5					4 5		2 5	5		

INTERVAL TIME:
6.250

TRAINING LEVEL	TASK NUMBER 31	32	33	34	35	36	37	38	39	40
1					3	1	1			
2	5	3 5	4 5	5	5	4 5	3 5		5	1
3		2	1		2		1			2
4								5		2 5
5										

INTERVAL TIME:
7.516

TRAINING LEVEL	TASK NUMBER 41	42	43	44	45	46	47	48	49	50
1			5	1						
2	4 5		3	4 5	3 5	5			4 5	3 5
3	1	5	1		1			5	1	2
4			1		1		5			
5										

INTERVAL TIME:
10.950

Figure G.3. Consensus Recordings for Group 1, Day 2, Career Field 4.

GROUP: 2 **DAY:** 1 **FACILITATOR:** SH **CAREER FIELD:** Ground Safety

TRAINING LEVEL / TASK NUMBER

LEVEL	1			2			3			4			5			6			7			8			9			10		
1																														
2							2	2	2										4	1	1	3	5					2		
3				1	5		3	3	3	1	4	4	3			5			1	4	4	2							4	5
4				4									1	5											1			2	1	
5	5									4	1	1	1												4	5		1		

INTERVAL TIME:
NA

TRAINING LEVEL / TASK NUMBER

LEVEL	11			12			13			14			15			16			17			18			19			20		
1																														
2	5			5			5						3	5								4			4			2	3	3
3										5			2			4	5			4	5	1	5		1	5		3	2	2
4																1			2	1										
5																			3											

INTERVAL TIME:
NA

TRAINING LEVEL / TASK NUMBER

LEVEL	21			22			23			24			25			26			27			28			29			30		
1	2			1												2	2	2							1					
2	3	5		2	2	5	5			2						3	3	3	5						4	5		5		
3					3					3	5											5								
4				2																										
5													5																	

INTERVAL TIME:
NA

TRAINING LEVEL / TASK NUMBER

LEVEL	31			32			33			34			35			36			37			38			39			40		
1	1			3			2						2	5		4	5													
2	3			1			3	5		5			3			1			4	4	5	5								
3	1	5		1	5														1	1					3					
4																									2	5		5		
5																														

INTERVAL TIME:
NA

TRAINING LEVEL / TASK NUMBER

LEVEL	41			42			43			44			45			46			47			48			49			50		
1							3																		2					
2	2			4			2	5		5			5			1			4	5		4	5		2	4	4	4	5	
3	3	5		1	5											4	5					1			1	1	1	1		
4																			1											
5																														

INTERVAL TIME:
NA

Figure G.4. Consensus Recordings for Group 2, Day 1, Career Field 1.

GROUP: 2 **DAY:** 1 **FACILITATOR:** SH **CAREER FIELD:** System Safety Engineer

TASK NUMBER

TRAINING LEVEL		1			2			3			4			5			6			7			8			9			10	
1	5			3	4		1			2						3			2			2			5			1		
2				2	1		3	1	1	3	5		1			2	5		2			2						2	5	
3							1	4	4				1						1	5		1	5					2		
4													3	5																
5																														

INTERVAL TIME:
21.350

TASK NUMBER

TRAINING LEVEL		11			12			13			14			15			16			17			18			19			20	
1	5			4			1												3	5								4	1	1
2				1	4	5	4	5		1									2									1	4	4
3					1					4	5											1								
4													5										5		1					
5																5						4			4	5				

INTERVAL TIME:
9.667

TASK NUMBER

TRAINING LEVEL		21			22			23			24			25			26			27			28			29			30	
1	3			1						5									1						5					
2	2	5		1	5		2	1	1										4	5										
3				3			2	4	4																					
4							1															2	4	4						
5													5			5						3	1	1				5		

INTERVAL TIME:
8.333

TASK NUMBER

TRAINING LEVEL		31			32			33			34			35			36			37			38			39			40	
1													5			5			2											
2	1						4	5											2			1						5		
3	4	5					1			5									1	5		4	5		1					
4				2	5																				4	5				
5				3																										

INTERVAL TIME:
6.667

TASK NUMBER

TRAINING LEVEL		41			42			43			44			45			46			47			48			49			50	
1																			1											
2				5			5			2									4	5										
3	5									3	5					5														
4													5												1			3	5	
5																						5			4	5		2		

INTERVAL TIME:
3.567

Figure G.5. Consensus Recordings for Group 2, Day 1, Career Field 2.

GROUP: 2 DAY: 2 FACILITATOR: GR CAREER FIELD: Industrial Shop Worker

TRAINING LEVEL / TASK NUMBER

TRAINING LEVEL	1			2			3			4			5			6			7			8			9			10		
1				1	1	1	2			1												3	5		2					
2	4	5		3	4	4	3	5		3	5		2	3	3	3	3	5	5			2			3	5		1		
3	1			1						1			3	2	2	2	2											2	5	
4																														
5																												2		

INTERVAL TIME:
41.917

TRAINING LEVEL / TASK NUMBER

TRAINING LEVEL	11			12			13			14			15			16			17			18			19			20		
1	5			2	4	4	1			3			2			5			2	5		5			5			5		
2				3	1	1	4	5			5		3	5					3											
3										2																				
4																														
5																														

INTERVAL TIME:
16.833

TRAINING LEVEL / TASK NUMBER

TRAINING LEVEL	21			22			23			24			25			26			27			28			29			30		
1	4	5		4	5		5			5						3			5						5			5		
2	1			1									3			2	5					5								
3													2	5																
4																														
5																														

INTERVAL TIME:
10.333

TRAINING LEVEL / TASK NUMBER

TRAINING LEVEL	31			32			33			34			35			36			37			38			39			40		
1	5			2			4	5		5			5			5			5			5						3	5	
2				3	5		1																		1	4	5	2		
3																									4	1				
4																														
5																														

INTERVAL TIME:
13.667

TRAINING LEVEL / TASK NUMBER

TRAINING LEVEL	41			42			43			44			45			46			47			48			49			50		
1	4			4			1						4			4			4			1			4			4		
2							1	4		2												2	4							
3							2			2																				
4											4											1								
5																														

INTERVAL TIME:
13.583

Figure G.6. Consensus Recordings for Group 2, Day 2, Career Field 3.

GROUP: 3 DAY: 1 FACILITATOR: TE CAREER FIELD: Fuels

TRAINING LEVEL	1			2			3			4			5			6			7			8			9			10		
1																														
2										1			1			1			1											
3							4			3	5		4	5		1			1						1	1		1		
4	4	5		4	5		1	5		1						3	5		2	5		4	5		4	4	5	4	5	
5	1			1															1			1			1					

INTERVAL TIME:
20.850

TRAINING LEVEL	11			12			13			14			15			16			17			18			19			20		
1																						1						1		
2	2	5		5			5			1			5			5			5			2	5		4	5		4	5	
3	3									3	4	4										2			1					
4											1	1																		
5										1																				

INTERVAL TIME:
16.667

TRAINING LEVEL	21			22			23			24			25			26			27			28			29			30		
1	1						2												1						4	5		3	5	
2	4	5					3	5								3	5		4	5		1			1			1		
3				2						1			2			2						2						1		
4				3	5					4	5		3	5								2	5							
5																														

INTERVAL TIME:
11.383

TRAINING LEVEL	31			32			33			34			35			36			37			38			39			40		
1				1																										
2	4	5		1			5			5			4	5		2			1			4	5					1		
3	1			2	5								1			1	2		3			1			1			1		
4				1												1	3	5	1	5					2			3	5	
5																1									2	5				

INTERVAL TIME:
13.750

TRAINING LEVEL	41			42			43			44			45			46			47			48			49			50		
1													1			2						1								
2	2	4	5	1	3	5	1						1	5		3	5		3	5		3	5		5			4	5	
3	2	1		3	2		2						2						2									1		
4	1			1			2	5		5			1									1								
5																														

INTERVAL TIME:
11.683

Figure G.7. Consensus Recordings for Group 3, Day 1, Career Field 1.

GROUP: 3 **DAY:** 1 **FACILITATOR:** TE **CAREER FIELD:** Plating

TRAINING LEVEL / **TASK NUMBER**

LEVEL	1	2	3	4	5	6	7	8	9	10
1										
2										
3				2	1			1		
4	5	4 5	5	3 5	4 5	2	4 5	3 5	5	4
5		1				3 5	1	1		1 5

INTERVAL TIME:
7.650

TRAINING LEVEL / **TASK NUMBER**

LEVEL	11	12	13	14	15	16	17	18	19	20
1										1
2	1 5	2 5	5	2		3		4 5	4 5	4 5
3	3	2		1	2	1 5	5	1	1	
4	1	1		1 5	2 5	1				
5				1	1					

INTERVAL TIME:
12.150

TRAINING LEVEL / **TASK NUMBER**

LEVEL	21	22	23	24	25	26	27	28	29	30
1				3 5					4 5	1
2	5		5	2		4 5	4 5	1	1	3 5
3							1	1		
4		5			5	1		3 5		1
5										

INTERVAL TIME:
6.783

TRAINING LEVEL / **TASK NUMBER**

LEVEL	31	32	33	34	35	36	37	38	39	40
1										
2	5		2	5	5		1	5		
3		4 5	2 5				2			
4		1	1			5	2 5			5
5									5	

INTERVAL TIME:
5.700

TRAINING LEVEL / **TASK NUMBER**

LEVEL	41	42	43	44	45	46	47	48	49	50
1								1		
2	5	5			3 5	5	4 5	4 5	5	5
3					2					
4			5	4			1			
5				1 5						

INTERVAL TIME:
6.967

Figure G.8. Consensus Recordings for Group 3, Day 1, Career Field 2.

GROUP: 3 **DAY:** 2 **FACILITATOR:** TE **CAREER FIELD:** Maintenance QA/QC

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1										
2										
3				2 5						
4	5	5	5	3	5	3	4	5	5	3
5						2 5	1 5			2 5

INTERVAL TIME:
11.500

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1										
2	2		4 5					2	2	5
3	1 5	5	1			5	5	3 5	3 5	
4	2			5	5					
5										

INTERVAL TIME:
13.733

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1									1	
2	5		5	3		4 5	5		4 5	5
3				5		1				
4		5		2	5			5		
5										

INTERVAL TIME:
7.600

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1										
2	5			5	4 5			5		
3			5		1					
4		5				5	5			5
5									5	

INTERVAL TIME:
5.067

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1										
2	3 5	5			1	5	1	2	3	
3	2				3 2		4 5	3 5	1 5	5
4			5		1 3 5				1	
5				5						

INTERVAL TIME:
12.583

Figure G.9. Consensus Recordings for Group 3, Day 2, Career Field 3.

GROUP: 3 DAY: 2 FACILITATOR: TE CAREER FIELD: Corrosion Control

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1										
2										
3				1						
4	3 5	5	5	4 5	5		3	5	5	
5	2					5	2 5			5

INTERVAL TIME:
7.200

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1										
2			5							5
3	5	5				4 5	5	5	5	
4				5	5	1				
5										

INTERVAL TIME:
3.833

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1				2						
2	5		5			5	5		5	5
3				3 5						
4		4 5			5			5		
5		1								

INTERVAL TIME:
6.650

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1										
2	5			5	5			5		
3			5							
4		5				5	5			5
5									5	

INTERVAL TIME:
3.183

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1										
2	5	5				5				
3							5	5	5	5
4			5		5					
5				5						

INTERVAL TIME:
2.916

Figure G.10. Consensus Recordings for Group 3, Day 2, Career Field 4.

GROUP: 4 **DAY:** 1 **FACILITATOR:** SI **CAREER FIELD:** Real Estate

TRAINING LEVEL	1			2			3			4			5			6			7			8			9			10		
1	1			4	5		5			1						5			1			5			1			3	5	
2	4	5		1						4	5		2						3	5					1			2		
3													1						1						3	5				
4													2	5																
5																														

INTERVAL TIME:
4.750

TRAINING LEVEL	11			12			13			14			15			16			17			18			19			20		
1				4	5		5			1			5			1			1			5						5		
2	1									3	5					3	5		4	5					2					
3				1						1						1									3	5				
4	4	5																												
5																														

INTERVAL TIME:
12.250

TRAINING LEVEL	21			22			23			24			25			26			27			28			29			30		
1				5			1			1			1			5			5			1						5		
2							4	5					2									2								
3	2									2	5		2	5								2	5							
4	3	5								2																				
5																									5					

INTERVAL TIME:
7.750

TRAINING LEVEL	31			32			33			34			35			36			37			38			39			40		
1				2			1									3			3	5								5		
2				3	5		3			1						2	5		2			5								
3	1						1	5		1			2												1					
4	2									2			2	5												5				
5	2	5								1	5		1												4					

INTERVAL TIME:
12.083

TRAINING LEVEL	41			42			43			44			45			46			47			48			49			50		
1				1	4	5	2			4	5		5			1			1			2	5		5			5		
2				2	1		1			1									4	5		2								
3							2									4	5					1								
4	5			2				5																						
5																														

INTERVAL TIME:
7.250

Figure G.11. Consensus Recordings for Group 4, Day 1, Career Field 1.

GROUP: 4 **DAY:** 1 **FACILITATOR:** SI **CAREER FIELD:** Contract Inspector

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1			1	1		1	1	4 5	2 3 5	3 5
2	1	2 2 2	3 5	1 4 5	1 1	4 5	3 5	1	2 2	2
3	1	2 3 3	1	2 1	3 4 5		1		1	
4	1 5	1			1					
5	2			1						

INTERVAL TIME:
39.583

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1	1	2 3 5	5	2 5			2 5	2 2	1	
2	1	2 2			3 4 5	4 5	3	2 3 5	3 5	
3	1	1		1	1 1	1		1		2
4	2			2					4	1 5
5	1 4 5				1					2

INTERVAL TIME:
21.167

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1	5	3	5	5	4 5	5	5	1	2	4 5
2		1 2 4			1				2	1
3		1						2 5	1 5	
4		1 2 1						2		
5										

INTERVAL TIME:
12.750

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1	5	2 1	4 5			5	5			4 5
2		2 2 5	1	3 5	5			1	1	
3		2		1				2	3 5	1
4				1				1 5	1	
5		1						1		

INTERVAL TIME:
12.167

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1	5	2	1	1	5	3 5	3 1	1	5	5
2		1	1	2 5		1	2 4 5	2		
3		2 5	1	2		1		1		
4		5	2 5					5		
5								1		

INTERVAL TIME:
14.083

Figure G.12. Consensus Recordings for Group 4, Day 1, Career Field 2.

GROUP: 4 **DAY:** 2 **FACILITATOR:** EM **CAREER FIELD:** Contracting

TRAINING LEVEL / **TASK NUMBER**

LEVEL	1	2	3	4	5	6	7	8	9	10
1	4 5	4 5	5	2 3		5	1	5	2 5	5
2	1	1		1 2 5			3 4 5		3	
3				3	4 5		1 1			
4					1					
5										

INTERVAL TIME:
17.083

TRAINING LEVEL / **TASK NUMBER**

LEVEL	11	12	13	14	15	16	17	18	19	20
1	1	5	5	4 5	1		4 5	1	3 5	
2	2 5			1	3 5		1	3 5	1	
3	1				1	5			1	
4	1							1		
5										5

INTERVAL TIME:
15.167

TRAINING LEVEL / **TASK NUMBER**

LEVEL	21	22	23	24	25	26	27	28	29	30
1	2	5	1	5	2	2 5	5	1	2	2
2	2 5		1		3 5	2		1	3 5	1
3	1		2			1		2 1		2 5
4			1 5					1 4 5		
5										

INTERVAL TIME:
16.833

TRAINING LEVEL / **TASK NUMBER**

LEVEL	31	32	33	34	35	36	37	38	39	40
1	1		1		2	5	4			1
2	1	4 5	3 4	3 1	2 5		1 5		2	2
3	1 5	1	1 1 5	1 4 5					1	1 5
4	2			1	1				1 5	1
5								5	1	

INTERVAL TIME:
20.700

TRAINING LEVEL / **TASK NUMBER**

LEVEL	41	42	43	44	45	46	47	48	49	50
1	1	4 5	5	1	3	2				
2	1	1		4 5	2 5	1	2		1	
3	3 5					1	1	1	2	
4						1 5	2 5		2 5	4 5
5								4 5		1

INTERVAL TIME:
11.300

Figure G.13. Consensus Recordings for Group 4, Day 2, Career Field 3.

GROUP: 5 **DAY:** 1 **FACILITATOR:** EM **CAREER FIELD:** MWR

TRAINING LEVEL	1			2			3			4			5			6			7			8			9			10		
1				2						1									1			5								
2	4	5								2	5		1	1					2						1			1		
3	1			1	2		4	4	3	2			2	2	1				1						1			2		
4				2	3	5	1	1	2					2	4	3	1			5					3	5		2	4	
5													2			2	4	5	1										1	5

INTERVAL TIME:
40.417

TRAINING LEVEL	11			12			13			14			15			16			17			18			19			20		
1	4			1			4	5														2						5		
2		4	5	3	5		1						1			2						3	5		5					
3	1	1								3			1			3	5		3											
4										2	5		2						1	4	5									
5				1									1	5					1	1										

INTERVAL TIME:
24.833

TRAINING LEVEL	21			22			23			24			25			26			27			28			29			30		
1				2	3		2									5			5									1		
2				1	2	5	3	5																	5			4	5	
3				2																										
4	4	5																				1								
5	1									5			5									4	5							

INTERVAL TIME:
9.667

TRAINING LEVEL	31			32			33			34			35			36			37			38			39			40		
1																4	5													
2																1			1											
3				1			5			5									1			3								
4				4	5								4	5					3			2	5		3			1		
5	5												1							5					2	5		4	5	

INTERVAL TIME:
11.500

TRAINING LEVEL	41			42			43			44			45			46			47			48			49			50		
1													4												1					
2				1									1	5		4	5		1			5			1					
3				3	5		5									1			2						3	5		5		
4	1			1															2	5										
5	4	5								5																				

INTERVAL TIME:
8.950

Figure G.14. Consensus Recordings for Group 5, Day 1, Career Field 1.

GROUP: 5 DAY: 1 FACILITATOR: EM CAREER FIELD: AAFES

TASK NUMBER

TRAINING LEVEL	1			2			3			4			5			6			7			8			9			10		
1																						4	5		2	3				
2	2	5								5			1									1			2	2	5			
3							5						1												1					
4	2			5									3	5		4	5		4	5										
5	1															1			1									5		

INTERVAL TIME:
8.167

TASK NUMBER

TRAINING LEVEL	11			12			13			14			15			16			17			18			19			20		
1	5						5																		1			4	5	
2																4	1								4	5		1		
3				1						2						1	4	5	3											
4				2	5					3	5								2	5		5								
5				3									5																	

INTERVAL TIME:
8.500

TASK NUMBER

TRAINING LEVEL	21			22			23			24			25			26			27			28			29			30		
1																5			5											
2				4			2																							
3	1				1		1																					3		
4	2			1	4	5	2	5																				1		
5	2	5								5			5									5			5			1	5	

INTERVAL TIME:
6.417

TASK NUMBER

TRAINING LEVEL	31			32			33			34			35			36			37			38			39			40		
1																5														
2													1	4	5															
3													1	1																
4				4			3	5		3	5		3						1			1								
5	5			1	5		2			2									4	5		4	5		5			5		

INTERVAL TIME:
8.417

TASK NUMBER

TRAINING LEVEL	41			42			43			44			45			46			47			48			49			50		
1																3	3													
2																1	1	5												
3																	1		1											
4				1									2									1								
5	5			4	5		5			5			3	5		1			4	5		4	5		5			5		

INTERVAL TIME:
5.500

Figure G.15. Consensus Recordings for Group 5, Day 1, Career Field 2.

GROUP: 5 **DAY:** 2 **FACILITATOR:** None **CAREER FIELD:** DECA

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1								5		
2	5	5	5	5		5			5	
3					5					
4							5			
5										5

INTERVAL TIME:
8.083

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1	5	5						5	5	5
2			5	5		5				
3										
4					5					
5							5			

INTERVAL TIME:
9.633

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1				4		5	5			5
2		5	5						5	
3										
4										
5	5			1	5			5		

INTERVAL TIME:
10.933

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1					5	5				
2	5			5			5			
3		5								
4			5					5		
5									5	5

INTERVAL TIME:
5.067

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1					5					
2	5					5			5	5
3			5					5		
4										
5		5		5			5			

INTERVAL TIME:
8.200

Figure G.16. Consensus Recordings for Group 5, Day 2, Career Field 3.

GROUP: 5 **DAY:** 2 **FACILITATOR:** None **CAREER FIELD:** Investigations

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1										
2										
3			5	5		1	5	5	5	
4						4				
5	5	5			5					5

INTERVAL TIME:
11.750

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1								5	5	
2			5		5					
3	5			5		5				5
4		5								
5							5			

INTERVAL TIME:
7.450

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1						5				5
2	5								5	
3		5	5				5			
4										
5				5	5			5		

INTERVAL TIME:
10.433

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1						5				
2					5		5			
3			5	5				5		
4	5	5							5	
5										5

INTERVAL TIME:
8.217

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1										
2	5				5	5			5	5
3				5			5	5		
4		5	5							
5										

INTERVAL TIME:
4.167

Figure G.17. Consensus Recordings for Group 5, Day 2, Career Field 4.

GROUP: 6 DAY: 1 FACILITATOR: None CAREER FIELD: Pest Control

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1				5				5		
2			5							
3	3					5			5	
4	2	5			5		5			
5										5

INTERVAL TIME:
41.500

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1		5				5		5	5	5
2	5		5							
3				5						
4							5			
5					5					

INTERVAL TIME:
4.583

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1	5	5	5	5		5	5		5	5
2										
3										
4					5			5		
5										

INTERVAL TIME:
17.417

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1				5		5	5	5	5	
2	5		5							
3										
4		5								
5					5					5

INTERVAL TIME:
4.367

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1		5		5	5	5	5	5		
2	5								5	5
3										
4										
5			5							

INTERVAL TIME:
17.383

Figure G.18. Consensus Recordings for Group 6, Day 1, Career Field 1.

GROUP: 6 **DAY:** 1 **FACILITATOR:** None **CAREER FIELD:** Photo Laboratory

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1				5				5		
2	5		5							
3					5	5			5	
4		5					5			
5										5

INTERVAL TIME:
5.583

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1	5	5		5		5	5	5	5	5
2			5							
3					5					
4										
5										

INTERVAL TIME:
9.917

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1	5	5	5	5			5		5	5
2						5				
3										
4					5			5		
5										

INTERVAL TIME:
3.000

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1	5		5	5	5	5	5	5	5	
2										
3										
4		5								
5										5

INTERVAL TIME:
3.333

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1		5				5	5	5		
2	5				5				5	5
3				5						
4			5							
5										

INTERVAL TIME:
6.283

Figure G.19. Consensus Recordings for Group 6, Day 1, Career Field 2.

GROUP: 6 DAY: 2 FACILITATOR: SI CAREER FIELD: Vehicle Maintenance

TASK NUMBER

TRAINING LEVEL	1			2			3			4			5			6			7			8			9			10		
1							1			4	5											4	5							
2	2	3	3				4	5		1			1									1			1					
3	3	2	2										2			4	5								4	5				
4				5									1	5		1			4	3	5									
5													1						1	2								5		

INTERVAL TIME:
28.000

TASK NUMBER

TRAINING LEVEL	11			12			13			14			15			16			17			18			19			20		
1	3			4	1		2	1	1	4	5					5			5			4	5		5			5		
2	2	5			4	5	3	4	4	1			1									1								
3				1									2	5																
4													2																	
5																														

INTERVAL TIME:
21.417

TASK NUMBER

TRAINING LEVEL	21			22			23			24			25			26			27			28			29			30		
1	5			4			5			5						1			5						5			5		
2													1			2														
3				1	5								1			2	5													
4													3	5								5								
5																														

INTERVAL TIME:
4.750

TASK NUMBER

TRAINING LEVEL	31			32			33			34			35			36			37			38			39			40		
1	1						2	1	1	5			1			4	4	5	4	1	1	5			5					
2	4	5					3	1	4				3	5		1	1		1	4	4									
3								3					1																	
4				5																										
5																												5		

INTERVAL TIME:
15.667

TASK NUMBER

TRAINING LEVEL	41			42			43			44			45			46			47			48			49			50		
1				4	5								2			5			4	5		3			1			1		
2	4	5		1									1						1						3	5		4	5	
3	1												2									2	5		1					
4							4	5		4	5			5																
5							1			1																				

INTERVAL TIME:
8.833

Figure G.20. Consensus Recordings for Group 6, Day 2, Career Field 3.

GROUP: 6 **DAY:** 2 **FACILITATOR:** 81 **CAREER FIELD:** Waste Treatment

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1				1						
2	1									
3	2 1	1	1	4 5		3 5			2	
4	4 5	4 5			3 3 5	1		1	3 5	
5	2		4 5		2 2	1	5	4 5		5

INTERVAL TIME:
20.500

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1					1	1				
2	2		3				1			
3	3 5		2 5	1	2	4 5	4 5		1	5
4				4 5	2 5			5	1 5	
5		5							3	

INTERVAL TIME:
5.750

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1	1						4		2	1
2	1						1 5		3 5	
3	3 5	1	4 5		1					1
4		4 5	1	5	4 5	5		5		5
5										

INTERVAL TIME:
6.250

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1				1		2 5			5	
2	1		2	1		3				
3	3 2 5		3 5	3 4 5	1 1 1		1	5		
4	1 3	3		1	1 4 4		4 5			
5		2 5			3					5

INTERVAL TIME:
13.750

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1						1				
2							1	3		
3	5	1		2		4 5		2 5		
4		4 5	4 5	3 5	5		3 5		5	5
5			1				1			

INTERVAL TIME:
13.583

Figure G.21. Consensus Recordings for Group 6, Day 2, Career Field 4.

GROUP: 7 **DAY:** 1 **FACILITATOR:** None **CAREER FIELD:** MPH

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1										
2				5					5	
3						5		5		
4	5	5	5							
5					5		5			5

INTERVAL TIME:
14.233

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1		5								
2								5	5	
3	5									5
4				5	5	5	5			
5			5							

INTERVAL TIME:
9.500

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1		5							5	
2				5						
3						5				5
4			5							
5	5				5		5	5		

INTERVAL TIME:
6.333

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1					5					
2							5			
3			5			5		5		
4	5	5		5					5	5
5										

INTERVAL TIME:
17.250

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1			5	5						
2									5	
3							5	5		
4										5
5	5	5			5	5				

INTERVAL TIME:
5.833

Figure G.22. Consensus Recordings for Group 7, Day 1, Career Field 1.

GROUP: 7 **DAY:** 1 **FACILITATOR:** None **CAREER FIELD:** MTF Commander

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1										
2		5	5	5			5	5	5	
3	5				5	5				5
4										
5										

INTERVAL TIME:
7.833

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1		5		5				5	5	5
2	5				5	5				
3			5							
4										
5							5			

INTERVAL TIME:
4.417

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1		5	5	5		5			5	5
2										
3					5		5			
4								5		
5	5									

INTERVAL TIME:
3.250

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1		5	5	5	5		5	5		
2										5
3									5	
4	5					5				
5										

INTERVAL TIME:
7.500

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1									5	
2				5	5		5			5
3			5					5		
4										
5	5	5				5				

INTERVAL TIME:
4.467

Figure G.23. Consensus Recordings for Group 7, Day 1, Career Field 2.

GROUP: 7 **DAY:** 2 **FACILITATOR:** None **CAREER FIELD:** MTF Plant Mgr

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1										
2			5	5		5		5	5	
3		5								5
4	5				5		5			
5										

INTERVAL TIME:
11.500

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1	5		5	5						
2		5			5				5	
3						5	5	5		5
4										
5										

INTERVAL TIME:
11.417

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1			5	5		5	5			
2	5									5
3		5			5					
4								5		
5									5	

INTERVAL TIME:
6.833

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1			5		5	5	5	5		
2		5		5						
3									5	
4	5									5
5										

INTERVAL TIME:
7.083

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1					5				5	
2						5				
3		5		5				5		
4			5				5			5
5	5									

INTERVAL TIME:
5.250

Figure G.24. Consensus Recordings for Group 7, Day 2, Career Field 3.

GROUP: 7 **DAY:** 2 **FACILITATOR:** None **CAREER FIELD:** MTF Logistics

TRAINING LEVEL	1	2	3	4	5	6	7	8	9	10
1	5		5	5				5	5	
2					5					
3										
4		5				5				5
5							5			

INTERVAL TIME:
6.917

TRAINING LEVEL	11	12	13	14	15	16	17	18	19	20
1	5	5	5	5		5	5	5	5	
2					5					
3										
4										5
5										

INTERVAL TIME:
4.583

TRAINING LEVEL	21	22	23	24	25	26	27	28	29	30
1		5	5	5		5	5		5	5
2										
3	5				5					
4								5		
5										

INTERVAL TIME:
2.717

TRAINING LEVEL	31	32	33	34	35	36	37	38	39	40
1		5	5	5	5	5	5			
2										
3									5	
4	5							5		5
5										

INTERVAL TIME:
2.450

TRAINING LEVEL	41	42	43	44	45	46	47	48	49	50
1					5				5	
2						5				
3										
4	5	5					5			5
5			5	5				5		

INTERVAL TIME:
3.567

Figure G.25. Consensus Recordings for Group 7, Day 2, Career Field 4.

Appendix H. Contingency Table/Chi-Square Test Results for Consensus

Level of Consensus

Experiment 1

Reached Consensus

Treatment	YES	NO	
GDSS	276	24	300
	283.06	16.94	
Fac-Manual	526	24	550
	518.94	31.06	
	802	48	850

TEST STATISTIC: Chi-Square (alpha = .05 & df = 1): 3.841
CHI-SQ (T Value): 4.8175017
DECISION: Reject Ho

Experiment 2

Reached Consensus

Treatment	YES	NO	
Fac-Manual	526	24	550
	534.37	15.63	
Manual	397	3	400
	388.63	11.37	
	923	27	950

TEST STATISTIC: Chi-Square (alpha = .05 & df = 1): 3.841
CHI-SQ (T Value): 10.9514019
DECISION: Reject Ho

Experiment 1: Reached Consensus

	GDSS		FAC-MAN		
Group	Yes	No	Yes	No	Total
1	30	20	96	4	150
2	47	3	89	11	150
3	199	1			200
4			148	2	150
5			98	2	100
6			95	5	100
Total:	276	24	526	24	850

Experiment 2: Reached Consensus

	FAC-MAN		MANUAL		
Group	Yes	No	Yes	No	Total
1	96	4			100
2	89	11			100
4	148	2			150
5	98	2	98	2	200
6	95	5	99	1	200
7			200		200
Total:	526	24	397	3	950

Figure H.1. Experiments 1 & 2: Level of Consensus.

Ability to Reach Consensus

Vote Counts to Consensus

Treatment	1	2	3	None	
GDSS	136	120	20	24	300
	115.41	143.65	24.00	16.94	
Fac-Manual	191	287	48	24	550
	211.59	263.35	44.00	31.06	
	327	407	68	48	850

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815
CHI-SQ (T Value): 17.26787
DECISION: Reject Ho

GDSS

Group	1 Vote	2 Votes	3 Votes	None	Total
1	3	14	13	20	50
2	25	20	2	3	50
3	108	86	5	1	200
Total:	136	120	20	24	300

Facilitated Manual

Group	1 Vote	2 Votes	3 Votes	None	Total
1	37	50	9	4	100
2	36	48	5	11	100
4	46	86	16	2	150
5	38	49	11	2	100
6	34	54	7	5	100
Total:	191	287	48	24	550

Figure H.2. Experiment 1: Number of Votes to Reach Consensus.

Appendix I. Chi-Square/Fisher's Exact Test Results for Consensus

EXPERIMENT 1: OVERALL CONSENSUS
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY CONSENS

FACILITY CONSENS(US REACHED)

Frequency / Expected	NO	YES	Total
FAC-MAN	24 31.059	526 518.94	550
GDSS	24 16.941	276 283.06	300
Total	48	802	850

STATISTICS FOR TABLE OF FACILITY BY CONSENS

Statistic	DF	Value	Prob
Chi-Square	1	4.818	0.028
Likelihood Ratio Chi-Square	1	4.616	0.032
Continuity Adj. Chi-Square	1	4.159	0.041
Mantel-Haenszel Chi-Square	1	4.812	0.028
Fisher's Exact Test (Left)			0.022
(Right)			0.990
(2-Tail)			0.042
Phi Coefficient		-0.075	
Contingency Coefficient		0.075	
Cramer's V		-0.075	

Sample Size = 850

EXPERIMENT 1: NUMBER OF VOTES TO REACH CONSENSUS
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY VOTES

FACILITY VOTES(TO REACH CONSENSUS)

Frequency / Expected	NONE	ONE	THREE	TWO	Total
FAC-MAN	24	191	48	287	550
	31.059	211.59	44	263.35	
GDSS	24	136	20	120	300
	16.941	115.41	24	143.65	
Total	48	327	68	407	850

STATISTICS FOR TABLE OF FACILITY BY VOTES

Statistic	DF	Value	Prob
Chi-Square	3	17.268	0.001
Likelihood Ratio Chi-Square	3	17.135	0.001
Mantel-Haenszel Chi-Square	1	16.088	0.000
Fisher's Exact Test (2-Tail)			6.41E-04
Phi Coefficient		0.143	
Contingency Coefficient		0.141	
Cramer's V		0.143	

Sample Size = 850

EXPERIMENT 2: OVERALL CONSENSUS
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY CONSENS

FACILITY CONSENS(US REACHED)

Frequency / Expected	NO	YES	Total
FAC-MAN	24 15.632	526 534.37	550
MANUAL	3 11.368	397 388.63	400
Total	27	923	950

STATISTICS FOR TABLE OF FACILITY BY CONSENS

Statistic	DF	Value	Prob
Chi-Square	1	10.951	0.001
Likelihood Ratio Chi-Square	1	12.898	0.000
Continuity Adj. Chi-Square	1	9.682	0.002
Mantel-Haenszel Chi-Square	1	10.940	0.001
Fisher's Exact Test (Left)			1.000
(Right)			4.47E-04
(2-Tail)			5.93E-04
Phi Coefficient		0.107	
Contingency Coefficient		0.107	
Cramer's V		0.107	

Sample Size = 950

Appendix J. Post-Process Questionnaire Results

Table J.1. Questionnaire Responses for Day 1

PERSON	SATISFIED W/ RESULTS	LEVEL OF DIFFICULTY	STAY FOCUSED	TIME EFFICIENCY	LEVEL OF CONFLICT	GROUP CONSENSUS	SATISFIED W/ PROCESS	LEVEL OF STRUCTURE
1-1	6	2	7	5	6	7	6	7
1-2	6	7	2	1	6	6	1	7
1-3	7	6	6	2	5	5	6	6
1-4	6	2	4	4	3	4	6	7
1-5	6	6	6	7	7	7	6	7
2-1	6	7	6	6	5	6	6	5
2-2	7	1	7	7	7	7	7	7
2-3	6	6	7	7	2	6	6	7
2-4	6	2	7	6	4	7	6	7
2-5	6	6	7	7	6	7	7	6
3-1	6	6	7	6	7	6	6	5
3-2	7	7	7	7	6	7	7	6
3-3	7	6	7	7	7	7	7	6
3-4	6	6	7	7	6	6	7	7
3-5	7	5	6	6	7	7	7	7
4-1	7	6	6	6	7	7	7	7
4-2	7	6	6	6	6	7	7	6
4-3	6	5	6	6	3	7	7	7
4-4	7	7	2	3	3	6	6	5
4-5	6	3	7	6	6	7	7	6
5-1	7	6	7	7	6	7	7	7
5-2	6	6	7	6	6	7	7	6
5-3	6	5	7	6	7	7	7	7
5-4	6	6	7	6	6	6	6	5
5-5	6	6	6	7	3	6	7	7
6-1	6	6	7	7	7	7	7	6
6-2	7	2	7	6	6	7	7	6
6-3	6	2	7	6	6	6	7	7
6-4	6	5	7	6	6	7	7	5
6-5	7	5	6	6	6	6	6	5
7-1	7	2	6	7	7	7	7	6
7-2	7	6	7	7	3	7	7	7
7-3	7	2	2	6	6	7	6	6
7-4	7	1	7	7	6	7	7	6
7-5	7	5	7	7	6	7	7	7

Table J.2. Questionnaire Responses for Day 2

PERSON	SATISFIED W/ RESULTS	LEVEL OF DIFFICULTY	STAY FOCUSED	TIME EFFICIENCY	LEVEL OF CONFLICT	GROUP CONSENSUS	SATISFIED W/ PROCESS	LEVEL OF STRUCTURE
1-1	7	5	7	7	3	7	7	6
1-2	6	2	7	7	6	7	6	7
1-3	7	4	7	7	6	7	7	5
1-4	6	1	7	7	2	7	6	6
1-5	7	1	7	7	7	7	7	7
2-1	6	6	6	6	4	6	5	6
2-2	6	6	6	6	7	7	7	6
2-3	6	6	7	6	3	7	6	6
2-4	6	4	6	6	3	7	6	7
2-5	7	5	7	7	6	7	7	5
3-1	6	4	7	7	6	7	7	6
3-2	7	5	7	7	6	7	7	6
3-3	7	1	7	7	7	7	7	6
3-4	6	5	7	7	6	7	7	7
3-5	7	2	7	7	6	7	7	7
4-1	7	6	7	7	7	7	7	7
4-2	7	5	6	7	3	7	7	6
4-3	6	5	7	6	6	7	6	6
4-4	7	1	7	7	7	7	7	6
4-5	7	2	7	7	7	7	7	7
5-1	7	6	7	7	6	7	7	7
5-2	6	6	6	6	7	6	7	6
5-3	6	5	7	7	7	7	6	6
5-4	6	5	6	6	6	6	6	5
5-5	7	5	6	7	6	7	7	6
6-1	6	6	7	3	6	6	2	7
6-2	6	6	6	2	5	6	2	7
6-3	5	3	7	6	6	6	6	7
6-4	6	5	6	6	6	6	7	6
6-5	4	5	4	6	5	4	4	6
7-1	7	2	7	7	7	7	7	6
7-2	7	6	7	7	3	7	7	7
7-3	7	2	7	7	7	7	7	6
7-4	7	1	7	7	6	7	7	6
7-5	7	6	7	7	6	7	7	6

INDIVIDUAL	SATISFACTION W/ RESULTS			LEVEL OF DIFFICULTY			REMAIN FOCUSED			TIME EFFICIENCY			LEVEL OF CONFLICT			LEVEL OF CONSENSUS			SATISFACTION W/ PROCESS			LEVEL OF STRUCTURE		
	DAY 1	DAY 2	COMPARE	DAY 1	DAY 2	COMPARE	DAY 1	DAY 2	COMPARE	DAY 1	DAY 2	COMPARE	DAY 1	DAY 2	COMPARE	DAY 1	DAY 2	COMPARE	DAY 1	DAY 2	COMPARE	DAY 1	DAY 2	COMPARE
1-1	6	7	TODAY	2	5	UNCHANGED	7	7	UNCHANGED	5	7	TODAY	6	3	UNCHANGED	7	7	TODAY	6	7	TODAY	7	6	TODAY
1-2	6	6	TODAY	7	2	UNCHANGED	2	7	UNCHANGED	1	7	TODAY	6	6	UNCHANGED	6	7	UNCHANGED	1	6	TODAY	7	7	TODAY
1-3	7	7	TODAY	6	4	YESTERDAY	6	7	TODAY	2	7	TODAY	5	6	YESTERDAY	5	7	TODAY	6	7	TODAY	6	5	YESTERDAY
1-4	6	6	TODAY	2	1	UNCHANGED	4	7	UNCHANGED	4	7	TODAY	3	2	YESTERDAY	4	7	TODAY	6	6	UNCHANGED	7	6	UNCHANGED
1-5	6	7	UNCHANGED	6	1	YESTERDAY	6	7	UNCHANGED	7	7	TODAY	7	7	UNCHANGED	7	7	UNCHANGED	6	7	UNCHANGED	7	7	UNCHANGED
2-1	6	6	UNCHANGED	7	6	TODAY	6	6	TODAY	6	6	UNCHANGED	5	4	UNCHANGED	6	6	UNCHANGED	6	5	UNCHANGED	5	6	UNCHANGED
2-2	7	6	UNCHANGED	1	6	TODAY	7	6	UNCHANGED	7	6	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	7	6	UNCHANGED
2-3	6	6	YESTERDAY	6	6	TODAY	7	7	UNCHANGED	7	6	YESTERDAY	2	3	UNCHANGED	6	7	UNCHANGED	6	6	UNCHANGED	7	6	UNCHANGED
2-4	6	6	UNCHANGED	2	4	UNCHANGED	7	6	UNCHANGED	6	6	UNCHANGED	4	3	UNCHANGED	7	7	UNCHANGED	6	6	UNCHANGED	7	7	UNCHANGED
2-5	6	7	TODAY	6	5	YESTERDAY	7	7	TODAY	7	7	TODAY	6	6	YESTERDAY	7	7	TODAY	7	7	UNCHANGED	6	5	UNCHANGED
3-1	6	6	TODAY	6	4	UNCHANGED	7	7	TODAY	6	7	TODAY	7	6	UNCHANGED	6	7	TODAY	6	7	TODAY	5	6	TODAY
3-2	7	7	UNCHANGED	7	5	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	6	6	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	6	6	UNCHANGED
3-3	7	7	UNCHANGED	6	1	YESTERDAY	7	7	UNCHANGED	7	7	TODAY	7	7	UNCHANGED	7	7	UNCHANGED	7	7	TODAY	6	6	UNCHANGED
3-4	6	6	TODAY	6	5	UNCHANGED	7	7	UNCHANGED	7	7	TODAY	6	6	UNCHANGED	6	7	TODAY	7	7	UNCHANGED	7	7	UNCHANGED
3-5	7	7	TODAY	5	2	YESTERDAY	6	7	TODAY	6	7	TODAY	7	6	UNCHANGED	7	7	UNCHANGED	7	7	TODAY	7	7	UNCHANGED
4-1	7	7	UNCHANGED	6	6	UNCHANGED	6	7	TODAY	6	7	TODAY	7	7	UNCHANGED	7	7	UNCHANGED	7	7	TODAY	7	7	UNCHANGED
4-2	7	7	UNCHANGED	6	5	YESTERDAY	6	6	TODAY	6	7	TODAY	6	3	YESTERDAY	7	7	TODAY	7	7	UNCHANGED	6	6	TODAY
4-3	6	6	TODAY	5	5	UNCHANGED	6	7	TODAY	6	6	TODAY	3	6	YESTERDAY	7	7	TODAY	7	6	UNCHANGED	7	6	YESTERDAY
4-4	7	7	TODAY	7	1	YESTERDAY	2	7	TODAY	3	7	TODAY	3	7	YESTERDAY	6	7	TODAY	6	7	TODAY	5	6	UNCHANGED
4-5	6	7	TODAY	3	2	YESTERDAY	7	7	UNCHANGED	6	7	TODAY	5	7	UNCHANGED	7	7	TODAY	7	7	TODAY	6	7	TODAY
5-1	7	7	UNCHANGED	6	6	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	6	6	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED
5-2	6	6	UNCHANGED	6	6	UNCHANGED	7	6	TODAY	6	6	TODAY	6	7	UNCHANGED	7	6	UNCHANGED	7	7	UNCHANGED	6	6	UNCHANGED
5-3	6	6	UNCHANGED	5	5	TODAY	7	7	UNCHANGED	6	7	TODAY	7	7	YESTERDAY	7	7	TODAY	7	6	YESTERDAY	7	6	YESTERDAY
5-4	6	6	UNCHANGED	6	5	UNCHANGED	7	6	UNCHANGED	6	6	UNCHANGED	6	6	UNCHANGED	6	6	UNCHANGED	6	6	UNCHANGED	5	5	UNCHANGED
5-5	6	7	UNCHANGED	6	5	UNCHANGED	6	6	UNCHANGED	7	7	TODAY	3	6	UNCHANGED	6	7	TODAY	7	7	TODAY	7	6	UNCHANGED
6-1	6	6	YESTERDAY	6	6	UNCHANGED	7	7	YESTERDAY	7	3	YESTERDAY	7	6	TODAY	7	6	YESTERDAY	7	2	YESTERDAY	6	7	YESTERDAY
6-2	7	6	YESTERDAY	2	6	TODAY	7	6	UNCHANGED	6	2	YESTERDAY	6	5	TODAY	7	6	YESTERDAY	7	2	YESTERDAY	6	7	TODAY
6-3	6	5	YESTERDAY	2	3	UNCHANGED	7	7	UNCHANGED	6	6	YESTERDAY	6	6	TODAY	6	6	YESTERDAY	7	6	UNCHANGED	7	7	UNCHANGED
6-4	6	6	UNCHANGED	5	5	UNCHANGED	7	6	YESTERDAY	6	6	UNCHANGED	4	6	TODAY	7	6	UNCHANGED	7	7	UNCHANGED	5	6	TODAY
6-5	7	4	YESTERDAY	5	5	UNCHANGED	6	4	YESTERDAY	6	6	UNCHANGED	6	5	TODAY	6	4	YESTERDAY	6	4	YESTERDAY	5	6	YESTERDAY
7-1	7	7	UNCHANGED	2	2	UNCHANGED	6	7	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	6	6	UNCHANGED
7-2	7	7	UNCHANGED	6	6	TODAY	7	7	UNCHANGED	7	7	UNCHANGED	3	3	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED
7-3	7	7	UNCHANGED	2	2	UNCHANGED	2	7	UNCHANGED	6	7	TODAY	6	7	UNCHANGED	7	7	UNCHANGED	6	7	UNCHANGED	6	6	UNCHANGED
7-4	7	7	UNCHANGED	1	1	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	6	6	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	6	6	UNCHANGED
7-5	7	7	UNCHANGED	5	6	UNCHANGED	7	7	UNCHANGED	7	7	TODAY	6	6	UNCHANGED	7	7	UNCHANGED	7	7	UNCHANGED	7	6	UNCHANGED

Table J.3. Reliability Data—Comparison of Participant Responses Between Days.

Appendix K. Contingency Table/Chi-Square Test Results for Participant Responses

QUESTION: ***How satisfied are you with the RESULTS your group produced?***

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS						6	4	10
	0.00	0.00	0.00	0.00	0.00	6.40	3.60	
Fac-Manual						10	5	15
	0.00	0.00	0.00	0.00	0.00	9.60	5.40	
	0	0	0	0	0	16	9	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 1): 3.841
CHI-SQ (T Value): 0.1157407
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS						6	4	10
	0.00	0.00	0.00	0.40	0.40	4.80	4.40	
Fac-Manual				1	1	6	7	15
	0.00	0.00	0.00	0.60	0.60	7.20	6.60	
	0	0	0	1	1	12	11	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815
CHI-SQ (T Value): 1.8939394
DECISION: Fail to Reject Ho

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual						10	5	15
	0.00	0.00	0.00	0.00	0.00	7.80	7.20	
Manual						3	7	10
	0.00	0.00	0.00	0.00	0.00	5.20	4.80	
	0	0	0	0	0	13	12	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 1): 3.841
CHI-SQ (T Value): 3.2318376
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual				1	1	6	7	15
	0.00	0.00	0.00	0.60	0.60	5.40	8.40	
Manual						3	7	10
	0.00	0.00	0.00	0.40	0.40	3.60	5.60	
	0	0	0	1	1	9	14	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815
CHI-SQ (T Value): 2.0833333
DECISION: Fail to Reject Ho

Figure K.1. Contingency Tables/Chi-Square Test: Results.

QUESTION: ***Taking all things into consideration, how DIFFICULT was this group process?***

Day 1
Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS		2			1	5	2	10
	0.40	1.20	0.40	0.00	1.20	5.20	1.60	
Fac-Manual	1	1	1		2	8	2	15
	0.60	1.80	0.60	0.00	1.80	7.80	2.40	
	1	3	1	0	3	13	4	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 5): 11.07
CHI-SQ (T Value): 2.457265
DECISION: Fail to Reject Ho

Day 2
Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS	1	1		2	3	3		10
	1.60	1.20	0.40	1.20	3.20	2.40	0.00	
Fac-Manual	3	2	1	1	5	3		15
	2.40	1.80	0.60	1.80	4.80	3.60	0.00	
	4	3	1	3	8	6	0	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 5): 11.07
CHI-SQ (T Value): 2.2569444
DECISION: Fail to Reject Ho

Day 1
Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual	1	1	1		2	8	2	15
	1.20	3.00	0.60	0.00	3.00	6.00	1.20	
Manual	1	4			3	2		10
	0.80	2.00	0.40	0.00	2.00	4.00	0.80	
	2	5	1	0	5	10	2	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 5): 11.07
CHI-SQ (T Value): 7.9166667
DECISION: Fail to Reject Ho

Day 2
Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual	3	2	1	1	5	3		15
	2.40	2.40	0.60	0.60	4.80	4.20	0.00	
Manual	1	2			3	4		10
	1.60	1.60	0.40	0.40	3.20	2.80	0.00	
	4	4	1	1	8	7	0	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 5): 11.07
CHI-SQ (T Value): 2.7529762
DECISION: Fail to Reject Ho

Figure K.2. Contingency Tables/Chi-Square Test: Difficulty.

QUESTION: ***To what degree was your group able to STAY FOCUSED on completing the task?***

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS	 0.00	1 0.80	 0.00	1 0.40	 0.00	3 3.20	5 5.60	10
Fac-Manual	 0.00	1 1.20	 0.00	 0.60	 0.00	5 4.80	9 8.40	15
	0	2	0	1	0	8	14	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815
CHI-SQ (T Value): 1.7113095
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS	 0.00	 0.00	 0.00	 0.40	 0.00	3 2.40	7 7.20	10
Fac-Manual	 0.00	 0.00	 0.00	1 0.60	 0.00	3 3.60	11 10.80	15
	0	0	0	1	0	6	18	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 0.9259259
DECISION: Fail to Reject Ho

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual	 0.00	1 1.20	 0.00	 0.00	 0.00	5 4.20	9 9.60	15
Manual	 0.00	1 0.80	 0.00	 0.00	 0.00	2 2.80	7 6.40	10
	0	2	0	0	0	7	16	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 0.5580357
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual	 0.00	 0.00	 0.00	1 0.60	 0.00	3 3.60	11 10.80	15
Manual	 0.00	 0.00	 0.00	 0.40	 0.00	3 2.40	7 7.20	10
	0	0	0	1	0	6	18	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 0.9259259
DECISION: Fail to Reject Ho

Figure K.3. Contingency Tables/Chi-Square Test: Stay Focused.

QUESTION: ***In terms of TIME EFFICIENCY, how productive was your group?***

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS	1	1		1	1	2	4	10
	0.40	0.40	0.40	0.40	0.40	4.40	3.60	
Fac-Manual			1			9	5	15
	0.60	0.60	0.60	0.60	0.60	6.60	5.40	
	1	1	1	1	1	11	9	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 6): 12.592

CHI-SQ (T Value): 8.9225589

DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS						4	6	10
	0.00	0.40	0.40	0.00	0.00	3.20	6.00	
Fac-Manual		1	1			4	9	15
	0.00	0.60	0.60	0.00	0.00	4.80	9.00	
	0	1	1	0	0	8	15	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815

CHI-SQ (T Value): 1.6666667

DECISION: Fail to Reject Ho

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual			1			9	5	15
	0.00	0.00	0.60	0.00	0.00	8.40	6.00	
Manual						5	5	10
	0.00	0.00	0.40	0.00	0.00	5.60	4.00	
	0	0	1	0	0	14	10	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991

CHI-SQ (T Value): 1.1904762

DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual		1	1			4	9	15
	0.00	0.60	0.60	0.00	0.00	3.60	10.20	
Manual						2	8	10
	0.00	0.40	0.40	0.00	0.00	2.40	6.80	
	0	1	1	0	0	6	17	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815

CHI-SQ (T Value): 1.7973856

DECISION: Fail to Reject Ho

Figure K.4. Contingency Tables/Chi-Square Test: Time Efficiency.

QUESTION: ***In terms of agreement/disagreement, what level of CONFLICT did your group experience?***

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS			1		1	4	4	10
	0.00	0.40	1.60	0.40	0.80	4.00	2.80	
Fac-Manual		1	3	1	1	6	3	15
	0.00	0.60	2.40	0.60	1.20	6.00	4.20	
	0	1	4	1	2	10	7	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 5): 11.07
CHI-SQ (T Value): 2.6488095
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS			2	1		5	2	10
	0.00	0.40	1.60	0.40	0.80	4.40	2.40	
Fac-Manual		1	2		2	6	4	15
	0.00	0.60	2.40	0.60	1.20	6.60	3.60	
	0	1	4	1	2	11	6	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 5): 11.07
CHI-SQ (T Value): 3.9141414
DECISION: Fail to Reject Ho

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual		1	3	1	1	6	3	15
	0.00	0.60	2.40	0.60	0.60	7.80	3.00	
Manual			1			7	2	10
	0.00	0.40	1.60	0.40	0.40	5.20	2.00	
	0	1	4	1	1	13	5	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 5): 11.07
CHI-SQ (T Value): 3.4134615
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual		1	2		2	6	4	15
	0.00	0.60	1.80	0.00	1.20	6.60	4.80	
Manual			1			5	4	10
	0.00	0.40	1.20	0.00	0.80	4.40	3.20	
	0	1	3	0	2	11	8	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 4): 9.488
CHI-SQ (T Value): 2.5252525
DECISION: Fail to Reject Ho

Figure K.5. Contingency Tables/Chi-Square Test: Conflict.

QUESTION: ***In terms of ABILITY TO REACH CONSENSUS, how productive was your group?***

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS				1	1	3	5	10
	0.00	0.00	0.00	0.40	0.40	3.20	6.00	
Fac-Manual						5	10	15
	0.00	0.00	0.00	0.60	0.60	4.80	9.00	
	0	0	0	1	1	8	15	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815
CHI-SQ (T Value): 3.2986111
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS						1	9	10
	0.00	0.00	0.00	0.40	0.00	2.00	7.60	
Fac-Manual				1		4	10	15
	0.00	0.00	0.00	0.60	0.00	3.00	11.40	
	0	0	0	1	0	5	19	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 1.9298246
DECISION: Fail to Reject Ho

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual						5	10	15
	0.00	0.00	0.00	0.00	0.00	4.20	10.80	
Manual						2	8	10
	0.00	0.00	0.00	0.00	0.00	2.80	7.20	
	0	0	0	0	0	7	18	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 1): 3.841
CHI-SQ (T Value): 0.5291005
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual				1		4	10	15
	0.00	0.00	0.00	0.60	0.00	3.60	10.80	
Manual						2	8	10
	0.00	0.00	0.00	0.40	0.00	2.40	7.20	
	0	0	0	1	0	6	18	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 0.9259259
DECISION: Fail to Reject Ho

Figure K.6. Contingency Tables/Chi-Square Test: Consensus.

QUESTION: ***Overall, how satisfied are you with the GROUP PROCESS you just completed?***

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS	1					5	4	10
	0.40	0.00	0.00	0.00	0.00	4.00	5.60	
Fac-Manual						5	10	15
	0.60	0.00	0.00	0.00	0.00	6.00	8.40	
	1	0	0	0	0	10	14	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815
CHI-SQ (T Value): 2.6785714
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS					1	2	7	10
	0.00	0.80	0.00	0.40	0.40	2.40	6.00	
Fac-Manual		2		1		4	8	15
	0.00	1.20	0.00	0.60	0.60	3.60	9.00	
	0	2	0	1	1	6	15	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 4): 9.488
CHI-SQ (T Value): 3.8888889
DECISION: Fail to Reject Ho

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual						5	10	15
	0.00	0.00	0.00	0.00	0.00	4.20	10.80	
Manual						2	8	10
	0.00	0.00	0.00	0.00	0.00	2.80	7.20	
	0	0	0	0	0	7	18	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 1): 3.841
CHI-SQ (T Value): 0.5291005
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual		2		1		4	8	15
	0.00	1.20	0.00	0.60	0.00	3.60	9.60	
Manual						2	8	10
	0.00	0.80	0.00	0.40	0.00	2.40	6.40	
	0	2	0	1	0	6	16	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 3): 7.815
CHI-SQ (T Value): 2.7777778
DECISION: Fail to Reject Ho

Figure K.7. Contingency Tables/Chi-Square Test: Process.

QUESTION: ***Based on your perceptions, how STRUCTURED was this group process?***

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS	 0.00	 0.00	 0.00	 0.00	1 1.60	3 2.80	6 5.60	10
Fac-Manual	 0.00	 0.00	 0.00	 0.00	3 2.40	4 4.20	8 8.40	15
	0	0	0	0	4	7	14	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 0.4464286
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
GDSS	 0.00	 0.00	 0.00	 0.00	1 0.80	6 5.20	3 4.00	10
Fac-Manual	 0.00	 0.00	 0.00	 0.00	1 1.20	7 7.80	7 6.00	15
	0	0	0	0	2	13	10	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 0.7051282
DECISION: Fail to Reject Ho

Day 1

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual	 0.00	 0.00	 0.00	 0.00	3 3.00	4 5.40	8 6.60	15
Manual	 0.00	 0.00	 0.00	 0.00	2 2.00	5 3.60	3 4.40	10
	0	0	0	0	5	9	11	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 1.6498316
DECISION: Fail to Reject Ho

Day 2

Ordinal Value Observations

Treatment	1	2	3	4	5	6	7	
Fac-Manual	 0.00	 0.00	 0.00	 0.00	1 1.20	7 8.40	7 5.40	15
Manual	 0.00	 0.00	 0.00	 0.00	1 0.80	7 5.60	2 3.60	10
	0	0	0	0	2	14	9	25

TEST STATISTIC: Chi-Square (alpha = .05 & df = 2): 5.991
CHI-SQ (T Value): 1.8518519
DECISION: Fail to Reject Ho

Figure K.8. Contingency Tables/Chi-Square Test: Structure.

Appendix L. Chi-Square/Fisher's Exact Test Results for Participant Responses

QUESTION 1: RESULTS, TEST 1, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY   LEVEL(ORDINAL VALUE OBSERVATION)

Frequency / Expected	6	7	Total
FCMN	10 9.6	5 5.4	15
GDSS	6 6.4	4 3.6	10
Total	16	9	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	1	0.116	0.734
Likelihood Ratio Chi-Square	1	0.115	0.734
Continuity Adj. Chi-Square	1	0.000	1.000
Mantel-Haenszel Chi-Square	1	0.111	0.739
Fisher's Exact Test (Left)			0.778
(Right)			0.530
(2-Tail)			1.000
Phi Coefficient		0.068	
Contingency Coefficient		0.068	
Cramer's V		0.068	

Sample Size = 25
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 1: RESULTS, TEST 1, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVATION)

Frequency / Expected	4	5	6	7	Total
FCMN	1	1	6	7	15
	0.6	0.6	7.2	6.6	
GDSS	0	0	6	4	10
	0.4	0.4	4.8	4.4	
Total	1	1	12	11	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	3	1.894	0.595
Likelihood Ratio Chi-Square	3	2.594	0.458
Mantel-Haenszel Chi-Square	1	0.190	0.663
Fisher's Exact Test (2-Tail)			0.888
Phi Coefficient		0.275	
Contingency Coefficient		0.265	
Cramer's V		0.275	

Sample Size = 25
WARNING: 75% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 1: RESULTS, TEST 2, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY	LEVEL(ORDINAL VALUE OBSERVED)		
Frequency / Expected	6	7	Total
FCMN	10 / 7.8	5 / 7.2	15
MANL	3 / 5.2	7 / 4.8	10
Total	13	12	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	1	3.232	0.072
Likelihood Ratio Chi-Square	1	3.305	0.069
Continuity Adj. Chi-Square	1	1.930	0.165
Mantel-Haenszel Chi-Square	1	3.103	0.078
Fisher's Exact Test (Left)			0.987
(Right)			0.082
(2-Tail)			0.111
Phi Coefficient		0.360	
Contingency Coefficient		0.338	
Cramer's V		0.360	

Sample Size = 25
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 1: RESULTS, TEST 2, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	4	5	6	7	Total
FCMN	1 0.6	1 0.6	6 5.4	7 8.4	15
MANL	0 0.4	0 0.4	3 3.6	7 5.6	10
Total	1	1	9	14	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	3	2.083	0.555
Likelihood Ratio Chi-Square	3	2.785	0.426
Mantel-Haenszel Chi-Square	1	1.910	0.167
Fisher's Exact Test (2-Tail)			0.884
Phi Coefficient		0.289	
Contingency Coefficient		0.277	
Cramer's V		0.289	

Sample Size = 25
WARNING: 63% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 2: DIFFICULTY, TEST 1, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	1	2	3	5	6	7	Total
FCMN	1	1	1	2	8	2	15
	0.6	1.8	0.6	1.8	7.8	2.4	
GDSS	0	2	0	1	5	2	10
	0.4	1.2	0.4	1.2	5.2	1.6	
Total	1	3	1	3	13	4	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	5	2.457	0.783
Likelihood Ratio Chi-Square	5	3.144	0.678
Mantel-Haenszel Chi-Square	1	0.019	0.889
Fisher's Exact Test (2-Tail)			0.972
Phi Coefficient		0.314	
Contingency Coefficient		0.299	
Cramer's V		0.314	

Sample Size = 25
WARNING: 83% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 2: DIFFICULTY, TEST 1, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	1	2	3	4	5	6	Total
FCMN	3	2	1	1	5	3	15
	2.4	1.8	0.6	1.8	4.8	3.6	
GDSS	1	1	0	2	3	3	10
	1.6	1.2	0.4	1.2	3.2	2.4	
Total	4	3	1	3	8	6	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	5	2.257	0.813
Likelihood Ratio Chi-Square	5	2.611	0.760
Mantel-Haenszel Chi-Square	1	0.640	0.424
Fisher's Exact Test (2-Tail)			0.907
Phi Coefficient		0.300	
Contingency Coefficient		0.288	
Cramer's V		0.300	

Sample Size = 25
WARNING: 100% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 2: DIFFICULTY, TEST 2, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	1	2	3	5	6	7	Total
FCMN	1	1	1	2	8	2	15
	1.2	3	0.6	3	6	1.2	
MANL	1	4	0	3	2	0	10
	0.8	2	0.4	2	4	0.8	
Total	2	5	1	5	10	2	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	5	7.917	0.161
Likelihood Ratio Chi-Square	5	9.136	0.104
Mantel-Haenszel Chi-Square	1	3.915	0.048
Fisher's Exact Test (2-Tail)			0.146
Phi Coefficient		0.563	
Contingency Coefficient		0.490	
Cramer's V		0.563	

Sample Size = 25
WARNING: 92% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 2: DIFFICULTY, TEST 2, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	1	2	3	4	5	6	Total
FCMN	3	2	1	1	5	3	15
	2.4	2.4	0.6	0.6	4.8	4.2	
MANL	1	2	0	0	3	4	10
	1.6	1.6	0.4	0.4	3.2	2.8	
Total	4	4	1	1	8	7	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	5	2.753	0.738
Likelihood Ratio Chi-Square	5	3.461	0.629
Mantel-Haenszel Chi-Square	1	0.583	0.445
Fisher's Exact Test (2-Tail)			0.926
Phi Coefficient		0.332	
Contingency Coefficient		0.315	
Cramer's V		0.332	

Sample Size = 25
WARNING: 100% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 3: STAY FOCUSED, TEST 1, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	2	4	6	7	Total
FCMN	1	0	5	9	15
	1.2	0.6	4.8	8.4	
GDSS	1	1	3	5	10
	0.8	0.4	3.2	5.6	
Total	2	1	8	14	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	3	1.711	0.634
Likelihood Ratio Chi-Square	3	2.044	0.563
Mantel-Haenszel Chi-Square	1	0.548	0.459
Fisher's Exact Test (2-Tail)			0.811
Phi Coefficient		0.262	
Contingency Coefficient		0.253	
Cramer's V		0.262	

Sample Size = 25
WARNING: 75% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 3: STAY FOCUSED, TEST 1, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	4	6	7	Total
FCMN	1	3	11	15
	0.6	3.6	10.8	
GDSS	0	3	7	10
	0.4	2.4	7.2	
Total	1	6	18	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	0.926	0.629
Likelihood Ratio Chi-Square	2	1.276	0.528
Mantel-Haenszel Chi-Square	1	0.122	0.726
Fisher's Exact Test (2-Tail)			0.799
Phi Coefficient		0.192	
Contingency Coefficient		0.189	
Cramer's V		0.192	

Sample Size = 25
WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 3: STAY FOCUSED, TEST 2, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency Expected	2	6	7	Total
FCMN	1 1.2	5 4.2	9 9.6	15
MANL	1 0.8	2 2.8	7 6.4	10
Total	2	7	16	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	0.558	0.757
Likelihood Ratio Chi-Square	2	0.572	0.751
Mantel-Haenszel Chi-Square	1	0.004	0.953
Fisher's Exact Test (2-Tail)			0.829
Phi Coefficient		0.149	
Contingency Coefficient		0.148	
Cramer's V		0.149	

Sample Size = 25
WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 3: STAY FOCUSED, TEST 2, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY   LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	4	6	7	Total
FCMN	1	3	11	15
	0.6	3.6	10.8	
MANL	0	3	7	10
	0.4	2.4	7.2	
Total	1	6	18	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	0.926	0.629
Likelihood Ratio Chi-Square	2	1.276	0.528
Mantel-Haenszel Chi-Square	1	0.122	0.726
Fisher's Exact Test (2-Tail)			0.799
Phi Coefficient		0.192	
Contingency Coefficient		0.189	
Cramer's V		0.192	

Sample Size = 25
WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 4: TIME EFFICIENCY, TEST 1, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	1	2	3	4	Total
FCMN	0	0	1	0	15
	0.6	0.6	0.6	0.6	
GDSS	1	1	0	1	10
	0.4	0.4	0.4	0.4	
Total	1	1	1	1	25

(Continued)

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	5	6	7	Total
FCMN	0	9	5	15
	0.6	6.6	5.4	
GDSS	1	2	4	10
	0.4	4.4	3.6	
Total	1	11	9	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	6	8.923	0.178
Likelihood Ratio Chi-Square	6	10.854	0.093
Mantel-Haenszel Chi-Square	1	2.005	0.157
Fisher's Exact Test (2-Tail)			0.097
Phi Coefficient		0.597	
Contingency Coefficient		0.513	
Cramer's V		0.597	

Sample Size = 25
WARNING: 86% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 4: TIME EFFICIENCY, TEST 1, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	2	3	6	7	Total
FCMN	1	1	4	9	15
	0.6	0.6	4.8	9	
GDSS	0	0	4	6	10
	0.4	0.4	3.2	6	
Total	1	1	8	15	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	3	1.667	0.644
Likelihood Ratio Chi-Square	3	2.370	0.499
Mantel-Haenszel Chi-Square	1	0.838	0.360
Fisher's Exact Test (2-Tail)			0.890
Phi Coefficient		0.258	
Contingency Coefficient		0.250	
Cramer's V		0.258	

Sample Size = 25
WARNING: 75% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 4: TIME EFFICIENCY, TEST 2, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	3	6	7	Total
FCMN	1	9	5	15
	0.6	8.4	6	
MANL	0	5	5	10
	0.4	5.6	4	
Total	1	14	10	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	1.190	0.551
Likelihood Ratio Chi-Square	2	1.538	0.463
Mantel-Haenszel Chi-Square	1	1.136	0.286
Fisher's Exact Test (2-Tail)			0.807
Phi Coefficient		0.218	
Contingency Coefficient		0.213	
Cramer's V		0.218	

Sample Size = 25
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 4: TIME EFFICIENCY, TEST 2, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	2	3	6	7	Total
FCMN	1 0.6	1 0.6	4 3.6	9 10.2	15
MANL	0 0.4	0 0.4	2 2.4	8 6.8	10
Total	1	1	6	17	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	3	1.797	0.616
Likelihood Ratio Chi-Square	3	2.504	0.475
Mantel-Haenszel Chi-Square	1	1.684	0.194
Fisher's Exact Test (2-Tail)			0.881
Phi Coefficient		0.268	
Contingency Coefficient		0.259	
Cramer's V		0.268	

Sample Size = 25
WARNING: 75% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 5: CONFLICT, TEST 1, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	2	3	4	5	6	7	Total
FCMN	1	3	1	1	6	3	15
	0.6	2.4	0.6	1.2	6	4.2	
GDSS	0	1	0	1	4	4	10
	0.4	1.6	0.4	0.8	4	2.8	
Total	1	4	1	2	10	7	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	5	2.649	0.754
Likelihood Ratio Chi-Square	5	3.358	0.645
Mantel-Haenszel Chi-Square	1	1.857	0.173
Fisher's Exact Test (2-Tail)			0.932
Phi Coefficient		0.326	
Contingency Coefficient		0.310	
Cramer's V		0.326	

Sample Size = 25
WARNING: 92% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 5: CONFLICT, TEST 1, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency Expected	2	3	4	5	6	7	Total
FCMN	1 0.6	2 2.4	0 0.6	2 1.2	6 6.6	4 3.6	15
GDSS	0 0.4	2 1.6	1 0.4	0 0.8	5 4.4	2 2.4	10
Total	1	4	1	2	11	6	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	5	3.914	0.562
Likelihood Ratio Chi-Square	5	5.309	0.379
Mantel-Haenszel Chi-Square	1	0.011	0.915
Fisher's Exact Test (2-Tail)			0.791
Phi Coefficient		0.396	
Contingency Coefficient		0.368	
Cramer's V		0.396	

Sample Size = 25
WARNING: 92% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 5: CONFLICT, TEST 2, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	2	3	4	5	6	7	Total
FCMN	1	3	1	1	6	3	15
	0.6	2.4	0.6	0.6	7.8	3	
MANL	0	1	0	0	7	2	10
	0.4	1.6	0.4	0.4	5.2	2	
Total	1	4	1	1	13	5	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	5	3.413	0.637
Likelihood Ratio Chi-Square	5	4.477	0.483
Mantel-Haenszel Chi-Square	1	1.563	0.211
Fisher's Exact Test (2-Tail)			0.874
Phi Coefficient		0.370	
Contingency Coefficient		0.347	
Cramer's V		0.370	

Sample Size = 25
WARNING: 83% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 5: CONFLICT, TEST 2, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY — LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	2	3	5	6	7	Total
FCMN	1	2	2	6	4	15
	0.6	1.8	1.2	6.6	4.8	
MANL	0	1	0	5	4	10
	0.4	1.2	0.8	4.4	3.2	
Total	1	3	2	11	8	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	4	2.525	0.640
Likelihood Ratio Chi-Square	4	3.583	0.465
Mantel-Haenszel Chi-Square	1	1.132	0.287
Fisher's Exact Test (2-Tail)			0.842
Phi Coefficient		0.318	
Contingency Coefficient		0.303	
Cramer's V		0.318	

Sample Size = 25

WARNING: 90% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 6: REACH CONSENSUS, TEST 1, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	4	5	6	7	Total
FCMN	0	0	5	10	15
	0.6	0.6	4.8	9	
GDSS	1	1	3	5	10
	0.4	0.4	3.2	6	
Total	1	1	8	15	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	3	3.299	0.348
Likelihood Ratio Chi-Square	3	3.970	0.265
Mantel-Haenszel Chi-Square	1	2.202	0.138
Fisher's Exact Test (2-Tail)			0.317
Phi Coefficient		0.363	
Contingency Coefficient		0.341	
Cramer's V		0.363	

Sample Size = 25
WARNING: 75% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 6: REACH CONSENSUS, TEST 1, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	4	6	7	Total
FCMN	1 0.6	4 3	10 11.4	15
GDSS	0 0.4	1 2	9 7.6	10
Total	1	5	19	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	1.930	0.381
Likelihood Ratio Chi-Square	2	2.360	0.307
Mantel-Haenszel Chi-Square	1	1.692	0.193
Fisher's Exact Test (2-Tail)			0.460
Phi Coefficient		0.278	
Contingency Coefficient		0.268	
Cramer's V		0.278	

Sample Size = 25
WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 6: REACH CONSENSUS, TEST 2, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	6	7	Total
FCMN	5 4.2	10 10.8	15
MANL	2 2.8	8 7.2	10
Total	7	18	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	1	0.529	0.467
Likelihood Ratio Chi-Square	1	0.544	0.461
Continuity Adj. Chi-Square	1	0.074	0.785
Mantel-Haenszel Chi-Square	1	0.508	0.476
Fisher's Exact Test (Left)			0.882
(Right)			0.399
(2-Tail)			0.659
Phi Coefficient		0.145	
Contingency Coefficient		0.144	
Cramer's V		0.145	

Sample Size = 25
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 6: REACH CONSENSUS, TEST 2, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	4	6	7	Total
FCMN	1 0.6	4 3.6	10 10.8	15
MANL	0 0.4	2 2.4	8 7.2	10
Total	1	6	18	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	0.926	0.629
Likelihood Ratio Chi-Square	2	1.282	0.527
Mantel-Haenszel Chi-Square	1	0.871	0.351
Fisher's Exact Test (2-Tail)			1.000
Phi Coefficient		0.192	
Contingency Coefficient		0.189	
Cramer's V		0.192	

Sample Size = 25
WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 7: GROUP PROCESS, TEST 1, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	1	6	7	Total
FCMN	0	5	10	15
	0.6	6	8.4	
GDSS	1	5	4	10
	0.4	4	5.6	
Total	1	10	14	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	2.679	0.262
Likelihood Ratio Chi-Square	2	3.036	0.219
Mantel-Haenszel Chi-Square	1	2.367	0.124
Fisher's Exact Test (2-Tail)			0.288
Phi Coefficient		0.327	
Contingency Coefficient		0.311	
Cramer's V		0.327	

Sample Size = 25
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 7: GROUP PROCESS, TEST 1, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	2	4	5	6	7	Total
FCMN	2	1	0	4	8	15
	1.2	0.6	0.6	3.6	9	
GDSS	0	0	1	2	7	10
	0.8	0.4	0.4	2.4	6	
Total	2	1	1	6	15	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	4	3.889	0.421
Likelihood Ratio Chi-Square	4	5.285	0.259
Mantel-Haenszel Chi-Square	1	1.508	0.219
Fisher's Exact Test (2-Tail)			0.614
Phi Coefficient		0.394	
Contingency Coefficient		0.367	
Cramer's V		0.394	

Sample Size = 25
WARNING: 80% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 7: GROUP PROCESS, TEST 2, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	6	7	Total
FCMN	5	10	15
	4.2	10.8	
MANL	2	8	10
	2.8	7.2	
Total	7	18	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	1	0.529	0.467
Likelihood Ratio Chi-Square	1	0.544	0.461
Continuity Adj. Chi-Square	1	0.074	0.785
Mantel-Haenszel Chi-Square	1	0.508	0.476
Fisher's Exact Test (Left)			0.882
(Right)			0.399
(2-Tail)			0.659
Phi Coefficient		0.145	
Contingency Coefficient		0.144	
Cramer's V		0.145	

Sample Size = 25
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 7: GROUP PROCESS, TEST 2, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY	LEVEL(ORDINAL VALUE OBSERVED)				
Frequency / Expected	2	4	6	7	Total
FCMN	2	1	4	8	15
	1.2	0.6	3.6	9.6	
MANL	0	0	2	8	10
	0.8	0.4	2.4	6.4	
Total	2	1	6	16	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	3	2.778	0.427
Likelihood Ratio Chi-Square	3	3.832	0.280
Mantel-Haenszel Chi-Square	1	2.481	0.115
Fisher's Exact Test (2-Tail)			0.654
Phi Coefficient		0.333	
Contingency Coefficient		0.316	
Cramer's V		0.333	

Sample Size = 25
WARNING: 75% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 8: STRUCTURE, TEST 1, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	5	6	7	Total
FCMN	3	4	8	15
	2.4	4.2	8.4	
GDSS	1	3	6	10
	1.6	2.8	5.6	
Total	4	7	14	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	0.446	0.800
Likelihood Ratio Chi-Square	2	0.470	0.791
Mantel-Haenszel Chi-Square	1	0.286	0.593
Fisher's Exact Test (2-Tail)			1.000
Phi Coefficient		0.134	
Contingency Coefficient		0.132	
Cramer's V		0.134	

Sample Size = 25
WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 8: STRUCTURE, TEST 1, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY   LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	5	6	7	Total
FCMN	1 1.2	7 7.8	7 6	15
GDSS	1 0.8	6 5.2	3 4	10
Total	2	13	10	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	0.705	0.703
Likelihood Ratio Chi-Square	2	0.716	0.699
Mantel-Haenszel Chi-Square	1	0.610	0.435
Fisher's Exact Test (2-Tail)			0.835
Phi Coefficient		0.168	
Contingency Coefficient		0.166	
Cramer's V		0.168	

Sample Size = 25
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 8: STRUCTURE, TEST 2, DAY 1
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	5	6	7	Total
FCMN	3	4	8	15
	3	5.4	6.6	
MANL	2	5	3	10
	2	3.6	4.4	
Total	5	9	11	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	1.650	0.438
Likelihood Ratio Chi-Square	2	1.664	0.435
Mantel-Haenszel Chi-Square	1	0.538	0.463
Fisher's Exact Test (2-Tail)			0.580
Phi Coefficient		0.257	
Contingency Coefficient		0.249	
Cramer's V		0.257	

Sample Size = 25
WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

QUESTION 8: STRUCTURE, TEST 2, DAY 2
CHI-SQUARE/FISHER EXACT TEST

TABLE OF FACILITY BY LEVEL

FACILITY LEVEL(ORDINAL VALUE OBSERVED)

Frequency / Expected	5	6	7	Total
FCMN	1	7	7	15
	1.2	8.4	5.4	
MANL	1	7	2	10
	0.8	5.6	3.6	
Total	2	14	9	25

STATISTICS FOR TABLE OF FACILITY BY LEVEL

Statistic	DF	Value	Prob
Chi-Square	2	1.852	0.396
Likelihood Ratio Chi-Square	2	1.935	0.380
Mantel-Haenszel Chi-Square	1	1.434	0.231
Fisher's Exact Test (2-Tail)			0.333
Phi Coefficient		0.272	
Contingency Coefficient		0.263	
Cramer's V		0.272	

Sample Size = 25
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Appendix M. Sign Test Results for Participant Responses and Questionnaire Reliability

Table M.1. Sign Test for Experiment 1, Results.

PERSON	GDSS	FAC-MAN	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
1-1	6	7	Lower	-	Lower	-	+
1-2	6	6	Equal	0	Lower	-	-
1-3	7	7	Equal	0	Lower	-	-
1-4	6	6	Equal	0	Lower	-	-
1-5	6	7	Lower	-	Equal	0	-
2-1	6	6	Equal	0	Equal	0	+
2-2	6	7	Lower	-	Equal	0	-
2-3	6	6	Equal	0	Lower	-	-
2-4	6	6	Equal	0	Equal	0	+
2-5	7	6	Higher	+	Higher	+	+
T:				1		1	4
n:				4		6	10
$P(x \leq T)$:				0.3125		0.1094	0.377
$P(x > T)$:				0.6875		0.8906	0.623
T needed to Reject Ho:				4		5	7
Decision (alpha=.05 compare; .10 reliability):							

Table M.2. Sign Test for Experiment 2, Results.

PERSON	FAC-MAN	MANUAL	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
5-1	7	7	Equal	0	Equal	0	+
5-2	6	6	Equal	0	Equal	0	+
5-3	6	6	Equal	0	Equal	0	+
5-4	6	6	Equal	0	Equal	0	+
5-5	6	7	Lower	-	Equal	0	-
6-1	6	6	Equal	0	Lower	-	-
6-2	6	7	Lower	-	Lower	-	+
6-3	5	6	Lower	-	Lower	-	+
6-4	6	6	Equal	0	Equal	0	+
6-5	4	7	Lower	-	Lower	-	+
T:				0		0	8
n:				4		4	10
$P(x \leq T)$:				0.0625		0.0625	0.9893
$P(x > T)$:				0.9375		0.9375	0.0107
T needed to Reject Ho:				4		4	7
Decision (alpha=.05 compare; .10 reliability):							Reject Ho

QUESTION: How satisfied are you with the RESULTS your group produced?

Table M.3. Sign Test for Experiment 1, Difficulty.

PERSON	GDSS	FAC-MAN	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
1-1	2	5	Lower	-	Equal	0	-
1-2	7	2	Higher	+	Equal	0	-
1-3	6	4	Higher	+	Higher	+	+
1-4	2	1	Higher	+	Equal	0	-
1-5	6	1	Higher	+	Higher	+	+
2-1	6	7	Lower	-	Higher	+	-
2-2	6	1	Higher	+	Higher	+	+
2-3	6	6	Equal	0	Higher	+	-
2-4	4	2	Higher	+	Equal	0	-
2-5	5	6	Lower	-	Lower	-	+
T:				6		5	4
n:				9		6	10
$P(x \leq T)$:				0.9102		0.9844	0.377
$P(x > T)$:				0.0898		0.0156	0.623
T needed to Reject Ho:				7		5	7
Decision (alpha=.05 compare; .10 reliability):						Reject Ho	

Table M.4. Sign Test for Experiment 2, Difficulty.

PERSON	FAC-MAN	MANUAL	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
5-1	6	6	Equal	0	Equal	0	+
5-2	6	6	Equal	0	Equal	0	+
5-3	5	5	Equal	0	Lower	-	-
5-4	6	5	Higher	+	Equal	0	-
5-5	6	5	Higher	+	Equal	0	-
6-1	6	6	Equal	0	Equal	0	+
6-2	6	2	Higher	+	Higher	+	+
6-3	3	2	Higher	+	Equal	0	-
6-4	5	5	Equal	0	Equal	0	+
6-5	5	5	Equal	0	Equal	0	+
T:				4		1	6
n:				4		2	10
$P(x \leq T)$:				1		0.75	0.8281
$P(x > T)$:				0		0.25	0.1719
T needed to Reject Ho:				4		2	7
Decision (alpha=.05 compare; .10 reliability):				Reject Ho			

QUESTION: Taking all things into consideration, how DIFFICULT was this group process?

Table M.5. Sign Test for Experiment 1, Stay Focused.

PERSON	GDSS	FAC-MAN	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
1-1	7	7	Equal	0	Equal	0	+
1-2	2	7	Lower	-	Equal	0	-
1-3	6	7	Lower	-	Lower	-	+
1-4	4	7	Lower	-	Equal	0	-
1-5	6	7	Lower	-	Equal	0	-
2-1	6	6	Equal	0	Higher	+	-
2-2	6	7	Lower	-	Equal	0	-
2-3	7	7	Equal	0	Equal	0	+
2-4	6	7	Lower	-	Equal	0	-
2-5	7	7	Equal	0	Higher	+	-
T:				0		2	3
n:				6		3	10
$P(x \leq T)$:				0.0156		0.875	0.1719
$P(x > T)$:				0.9844		0.125	0.8281
T needed to Reject Ho:				5		3	7
Decision (alpha=.05 compare; .10 reliability):							

Table M.6. Sign Test for Experiment 2, Stay Focused.

PERSON	FAC-MAN	MANUAL	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
5-1	7	7	Equal	0	Equal	0	+
5-2	7	6	Higher	+	Lower	-	-
5-3	7	7	Equal	0	Equal	0	+
5-4	7	6	Higher	+	Equal	0	-
5-5	6	6	Equal	0	Equal	0	+
6-1	7	7	Equal	0	Lower	-	-
6-2	6	7	Lower	-	Equal	0	-
6-3	7	7	Equal	0	Equal	0	+
6-4	6	7	Lower	-	Lower	-	+
6-5	4	6	Lower	-	Lower	-	+
T:				2		0	6
n:				5		4	10
$P(x \leq T)$:				0.5		0.0625	0.8281
$P(x > T)$:				0.5		0.9375	0.1719
T needed to Reject Ho:				4		4	7
Decision (alpha=.05 compare; .10 reliability):							

QUESTION: To what degree was your group able to STAY FOCUSED on completing the task?

Table M.7. Sign Test for Experiment 1, Time Efficiency.

PERSON	GDSS	FAC-MAN	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
1-1	5	7	Lower	-	Lower	-	+
1-2	1	7	Lower	-	Lower	-	+
1-3	2	7	Lower	-	Lower	-	+
1-4	4	7	Lower	-	Lower	-	+
1-5	7	7	Equal	0	Lower	-	-
2-1	6	6	Equal	0	Equal	0	+
2-2	6	7	Lower	-	Equal	0	-
2-3	6	7	Lower	-	Lower	-	+
2-4	6	6	Equal	0	Equal	0	+
2-5	7	7	Equal	0	Higher	+	-
T:				0		1	7
n:				6		7	10
$P(x \leq T)$:				0.0156		0.0625	0.9453
$P(x > T)$:				0.9844		0.9375	0.0547
T needed to Reject Ho:				5		6	7
Decision (alpha=.05 compare; .10 reliability):							Reject Ho

Table M.8. Sign Test for Experiment 2, Time Efficiency.

PERSON	FAC-MAN	MANUAL	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
5-1	7	7	Equal	0	Equal	0	+
5-2	6	6	Equal	0	Lower	-	-
5-3	6	7	Lower	-	Lower	-	+
5-4	6	6	Equal	0	Equal	0	+
5-5	7	7	Equal	0	Lower	-	-
6-1	3	7	Lower	-	Lower	-	+
6-2	2	6	Lower	-	Lower	-	+
6-3	6	6	Equal	0	Lower	-	-
6-4	6	6	Equal	0	Equal	0	+
6-5	6	6	Equal	0	Equal	0	+
T:				0		0	7
n:				3		6	10
$P(x \leq T)$:				0.125		0.0156	0.9453
$P(x > T)$:				0.875		0.9844	0.0547
T needed to Reject Ho:				3		5	7
Decision (alpha=.05 compare; .10 reliability):							Reject Ho

QUESTION: In terms of TIME EFFICIENCY, how productive was your group?

Table M.9. Sign Test for Experiment 1, Conflict.

PERSON	GDSS	FAC-MAN	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
1-1	6	3	Higher	+	Equal	0	-
1-2	6	6	Equal	0	Equal	0	+
1-3	5	6	Lower	-	Higher	+	-
1-4	3	2	Higher	+	Higher	+	+
1-5	7	7	Equal	0	Equal	0	+
2-1	4	5	Lower	-	Equal	0	-
2-2	7	7	Equal	0	Equal	0	+
2-3	3	2	Higher	+	Equal	0	-
2-4	3	4	Lower	-	Equal	0	-
2-5	6	6	Equal	0	Lower	-	-
T:				3		2	4
n:				6		3	10
$P(x \leq T)$:				0.6563		0.875	0.377
$P(x > T)$:				0.3437		0.125	0.623
T needed to Reject Ho:				5		3	7
Decision (alpha=.05 compare: .10 reliability):							

Table M.10. Sign Test for Experiment 2, Conflict.

PERSON	FAC-MAN	MANUAL	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
5-1	6	6	Equal	0	Equal	0	+
5-2	6	7	Lower	-	Equal	0	-
5-3	7	7	Equal	0	Higher	+	-
5-4	6	6	Equal	0	Equal	0	+
5-5	3	6	Lower	-	Equal	0	-
6-1	6	7	Lower	-	Higher	+	-
6-2	5	6	Lower	-	Higher	+	-
6-3	6	6	Equal	0	Higher	+	-
6-4	6	6	Equal	0	Higher	+	-
6-5	5	6	Lower	-	Higher	+	-
T:				0		6	2
n:				5		6	10
$P(x \leq T)$:				0.0313		1	0.5047
$P(x > T)$:				0.9687		0	0.9453
T needed to Reject Ho:				4		5	7
Decision (alpha=.05 compare: .10 reliability):						Reject Ho	

QUESTION: In terms of agreement/disagreement, what level of CONFLICT did your group experience?

Table M.11. Sign Test for Experiment 1, Consensus.

PERSON	GDSS	FAC-MAN	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
1-1	7	7	Equal	0	Lower	-	-
1-2	6	7	Lower	-	Equal	0	-
1-3	5	7	Lower	-	Lower	-	+
1-4	4	7	Lower	-	Lower	-	+
1-5	7	7	Equal	0	Equal	0	+
2-1	6	6	Equal	0	Equal	0	+
2-2	7	7	Equal	0	Equal	0	+
2-3	7	6	Higher	+	Equal	0	-
2-4	7	7	Equal	0	Equal	0	+
2-5	7	7	Equal	0	Higher	+	-
T:				1		1	6
n:				4		4	10
$P(x \leq T)$:				0.3125		0.3125	0.8281
$P(x > T)$:				0.6875		0.6875	0.1719
T needed to Reject Ho:				4		4	7
Decision (alpha=.05 compare; .10 reliability):							

Table M.12. Sign Test for Experiment 2, Consensus.

PERSON	FAC-MAN	MANUAL	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
5-1	7	7	Equal	0	Equal	0	+
5-2	7	6	Higher	+	Equal	0	-
5-3	7	7	Equal	0	Lower	-	-
5-4	6	6	Equal	0	Equal	0	+
5-5	6	7	Lower	-	Lower	-	+
6-1	6	7	Lower	-	Lower	-	+
6-2	6	7	Lower	-	Lower	-	+
6-3	6	6	Equal	0	Lower	-	-
6-4	6	7	Lower	-	Equal	0	-
6-5	4	6	Lower	-	Lower	-	+
T:				1		0	6
n:				6		6	10
$P(x \leq T)$:				0.1094		0.0156	0.8281
$P(x > T)$:				0.8906		0.9844	0.1719
T needed to Reject Ho:				5		5	7
Decision (alpha=.05 compare; .10 reliability):							

QUESTION: In terms of ABILITY TO REACH CONSENSUS, how productive was your group?

Table M.13. Sign Test for Experiment 1, Process.

PERSON	GDSS	FAC-MAN	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
1-1	6	7	Lower	-	Lower	-	+
1-2	1	6	Lower	-	Lower	-	+
1-3	6	7	Lower	-	Lower	-	+
1-4	6	6	Equal	0	Equal	0	+
1-5	6	7	Lower	-	Equal	0	-
2-1	5	6	Lower	-	Equal	0	-
2-2	7	7	Equal	0	Equal	0	+
2-3	6	6	Equal	0	Equal	0	+
2-4	6	6	Equal	0	Equal	0	+
2-5	7	7	Equal	0	Equal	0	+
T:				0		0	8
n:				5		3	10
$P(x \leq T)$:				0.0313		0.125	0.9893
$P(x > T)$:				0.9687		0.875	0.0107
T needed to Reject Ho:				4		3	7
Decision (alpha=.05 compare; .10 reliability):							Reject Ho

Table M.14. Sign Test for Experiment 2, Process.

PERSON	FAC-MAN	MANUAL	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
5-1	7	7	Equal	0	Equal	0	+
5-2	7	7	Equal	0	Equal	0	+
5-3	7	6	Higher	+	Higher	+	+
5-4	6	6	Equal	0	Equal	0	+
5-5	7	7	Equal	0	Lower	-	-
6-1	2	7	Lower	-	Lower	-	+
6-2	2	7	Lower	-	Lower	-	+
6-3	6	7	Lower	-	Equal	0	-
6-4	7	7	Equal	0	Equal	0	+
6-5	4	6	Lower	-	Lower	-	+
T:				1		1	8
n:				5		5	10
$P(x \leq T)$:				0.1875		0.1875	0.9893
$P(x > T)$:				0.8125		0.8125	0.0107
T needed to Reject Ho:				4		4	7
Decision (alpha=.05 compare; .10 reliability):							Reject Ho

QUESTION: Overall, how satisfied are you with the GROUP PROCESS you just completed?

Table M.15. Sign Test for Experiment 1, Structure.

PERSON	GDSS	FAC-MAN	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
1-1	7	6	Higher	+	Lower	-	-
1-2	7	7	Equal	0	Lower	-	-
1-3	6	5	Higher	+	Higher	+	+
1-4	7	6	Higher	+	Equal	0	-
1-5	7	7	Equal	0	Equal	0	+
2-1	6	5	Higher	+	Equal	0	-
2-2	6	7	Lower	-	Equal	0	-
2-3	6	7	Lower	-	Equal	0	-
2-4	7	7	Equal	0	Equal	0	+
2-5	5	6	Lower	-	Equal	0	-
T:				4		1	3
n:				7		3	10
$P(x \leq T)$:				0.7734		0.5	0.1719
$P(x > T)$:				0.2266		0.5	0.8281
T needed to Reject Ho:				6		3	7
Decision (alpha=.05 compare; .10 reliability):							

Table M.16. Sign Test for Experiment 2, Structure.

PERSON	FAC-MAN	MANUAL	OBJECTIVE COMPARISON	SIGN TEST	SUBJECTIVE COMPARISON	SIGN TEST	RELIABILITY SIGN TEST
5-1	7	7	Equal	0	Equal	0	+
5-2	6	6	Equal	0	Equal	0	+
5-3	7	6	Higher	+	Higher	+	+
5-4	5	5	Equal	0	Equal	0	+
5-5	7	6	Higher	+	Equal	0	-
6-1	7	6	Higher	+	Lower	-	-
6-2	7	6	Higher	+	Higher	+	+
6-3	7	7	Equal	0	Equal	0	+
6-4	6	5	Higher	+	Higher	+	+
6-5	6	5	Higher	+	Lower	-	-
T:				6		3	7
n:				6		5	10
$P(x \leq T)$:				1		0.8125	0.9453
$P(x > T)$:				0		0.1875	0.0547
T needed to Reject Ho:				5		4	7
Decision (alpha=.05 compare; .10 reliability):				Reject Ho			Reject Ho

QUESTION: Based on your perceptions, how STRUCTURED was this group process?

Appendix N. Facilitator Comments

The following comments were obtained from the facilitators through written comments provided on the Data Collection Forms and verbally through post-process interviews.

FACILITATOR. SH
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 1
DAY: 2
CAREER FIELD: Manufacturing Engineering

1. This group feels that there are not too many true manufacturing engineers left in the USAF. These professionals are now process engineers.
2. One subject did not show much interest in anything.
3. The group is not too happy nor satisfied with the task definitions.
4. Two subjects dominate the discussion. One other subject is not so interested, and another only gives quick, crisp answers.
5. The group feels that they are voting for someone who does not exist.

FACILITATOR: SH
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 1
DAY: 2
CAREER FIELD: Toxicologist

1. Only two subjects know anything about the subject matter.

FACILITATOR: SH
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 2
DAY: 1
CAREER FIELD: Ground Safety

1. Two individuals were very influential.

FACILITATOR: SH
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 2
DAY: 1
CAREER FIELD: System Safety

1. The group feels that the proper term is System Safety Engineer rather than System Safety.
2. There are many doubts on the wording of the tasks.
3. Subjects constantly asked for scores of previous tasks.

FACILITATOR: GR
TREATMENT: GDSS
GROUP: 2
DAY: 2
CAREER FIELD: Industrial Shop Worker

1. The group discussed the task meanings prior to the initial vote. They did not discuss the task in relation to the career field being considered.
2. The members had more problems casting votes.
3. Member 2-4 departed early to catch an airplane. Resulted in missing last interval. Interval time before departure was practically identical to the interval following departure, 13.67 and 13.58 minutes, respectively.

FACILITATOR: GR
TREATMENT: GDSS
GROUP: 2
DAY: 2
CAREER FIELD: Industrial Shop Supervisor

1. The voting process was abandoned for expediency purposes. Votes were cast across all tasks simultaneously with resolution of only those not reaching consensus.
2. One member stood up to address the group on two occasions in order to emphasize a point. The member stood up to speak over the computer terminals which were physically a communications barrier.

FACILITATOR: TE
TREATMENT: GDSS
GROUP: 3
DAY: 1
CAREER FIELD: Fuels

1. There is no fuels professional represented in this group.
2. Group members did not often understand the tasks. Discussion of task definitions, not the career field, often occurred at the beginning of the voting process.

FACILITATOR: TE
TREATMENT: GDSS
GROUP: 3
DAY: 1
CAREER FIELD: Plating

1. The history about previous careers affects consistency.

FACILITATOR: TE
TREATMENT: GDSS
GROUP: 3
DAY: 2
CAREER FIELD: Maintenance QA/QC

1. There is no such career field, but a mix of specialties.

FACILITATOR: SI
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 4
DAY: 1
CAREER FIELD: Real Estate

1. The group is relying strongly on the opinion of the real estate professional in the group.
2. Many times on the initial or second vote, members hesitated in voting until the real estate professional cast his vote. Although the facilitator discouraged this practice, the real estate professional was very influential on the second vote. This may have led to quicker consensus for this group with this career field.

FACILITATOR: SI
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 4
DAY: 1
CAREER FIELD: Contract Inspector

1. The group interpreted this career field to be a technician/engineer assisting the Procurement Contracting Officer in quality assurance (i.e., construction or manufacturing plant floor inspector).
2. Some small discussion occurred before some first votes in order to clarify the task (no value opinions offered).

FACILITATOR: EM
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 4
DAY: 2
CAREER FIELD: Procurement

1. Procurement and contracting are the same career field (contracting is the old terminology). The group will not vote on contracting as a separate career field.
2. An additional person (six total) participated in this group's discussions, but did not vote nor fill out any questionnaires. This individual, the supervisor for one group member, wanted to sit in on the group's discussions and had limited influence over the group's discussion and the decision making process.
3. This was an excellent group. The members were intelligent, well-disciplined, and they exhibited mature adult behavior. The discussions were open and frank.

FACILITATOR: EM
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 5
DAY: 1
CAREER FIELD: Morale, Welfare, and Recreation

1. There are three MWR professionals in this group.

FACILITATOR: EM
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 5
DAY: 1
CAREER FIELD: Army, Air Force Exchange Service

1. There were no AAFES representatives in this group. Discussions did not proceed very far, since the group had no expertise in this area. This may have led to more rapid consensus, and did result in full consensus on all tasks.
2. The air conditioner came on and stayed on during this career field. By the end of this session, the members were cold. This factor probably contributed to more rapidly decision making.
3. Since AAFES is its own agency, the group members felt that this career field required higher training levels, frequently level five.

FACILITATOR: SI
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 6
DAY: 2
CAREER FIELD: Vehicle Maintenance

1. One group member (who participated in an non-facilitated process on Day 1) did not like the facilitated, structured process. He wanted to eliminate the first vote and begin with a discussion session. The group decided to stay with the three-vote process.
2. The group spent a great deal of discussion to clarify tasks and to clarify the 5-point rating scale (training levels).
3. The group had trouble distinguishing between level four and five ratings.

FACILITATOR: SI
TREATMENT: FAC-MAN (non-GDSS)
GROUP: 6
DAY: 2
CAREER FIELD: Waste Treatment - Hazardous Material

1. The group spent 10 minutes (not recorded) of discussion prior to start of the voting process in order to define the career field.

Appendix O. Participant Comments

GROUP: 1
TREATMENT: GDSS
DAY: 1
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Efficient voting process (automated).
2. Opportunity for discussion was good.
3. Need to reach consensus.
4. Well-organized and planned—ready for group.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Three vote process could work better if consensus is clear goal. Slow, but shares understanding of subject.
2. Grossly time-consuming. No flexibility. Not consulted on process beforehand—held hostage to an AFIT experiment without permission.
3. Took too long—over 2 1/2 hours for first one. Should vote all at once then come back and discuss.
4. Took too much time!

GENERAL COMMENTS:

1. Process change for Process Engineer—identify similarities between Process Engineer and Material Engineer, then deal with non-consensus by exception. Narrative process by facilitator slowed first process.
2. Second part (career field) was much better, but required that first was reviewed using other procedure.
3. We improved the process on the second round by comparing and highlighting differences in the two engineers.
4. Process of doing the second career field: I think that the process was as good or better than the proposed method, since the two fields were similar.
5. Overall, not bad. Second process run on Process Engineer career field: we used Materials Engineer as baseline due to similarity to Process Engineer and then addressed only those items not the same as an exception.

GROUP: 1
TREATMENT: FAC-MAN (non-GDSS)
DAY: 2
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Cards promote team building and consensus and understanding.
2. Much quicker. More efficient for small group. Can communicate differences/resolve faster.
3. Worked well with software and well as with cards. The card system provided better interaction, communication, and was quicker.
4. More efficient today. Better communications (e.g., faster).

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Computer interferes with group communication.
2. More peer pressure for consensus.
3. Computer process work was too long.

4. Uncertainty over several of the tasks as to what they meant.

GENERAL COMMENTS:

1. Day 2 also had better understanding of issues being decided.
2. For small groups, this system is preferred. Larger groups would benefit from computer software.
3. Manual card system best for small groups—more timely with at least as good product.
4. Pencil/paper method (today) faster and more efficient for a small group like this.

GROUP: 2
TREATMENT: FAC-MAN (non-GDSS)
DAY: 1
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Personally, I now have a better understanding of the types and amounts of environmental training needed.
2. Good group, excellent leader.
3. This was fun.
4. Significant ability to accommodate varying viewpoints.
5. Group exchanged ideas and worked towards consensus.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. We had to make assumptions of "occupations." Not consistent (i.e., System Safety vs System Safety Engineer—Big Difference).
2. Was not clear with definition of category I, II, and III stuff.
3. Tendency to hurry the process.
4. Basic definitions were in doubt and had to be resolved by opinion rather than fact.

GENERAL COMMENTS:

1. Need to receive feedback on overall result.

GROUP: 2
TREATMENT: GDSS
DAY: 2
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. The facilitator helped by repeating the task several times with the type of worker keeping focus on the vote at hand.
2. Team members could both talk about details and could listen—good group dynamics.
3. Easier to discriminate due to subject matter.
4. Due to use of the computer, easier to recall own position and the group's overall position—helped focus.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. The group generally wanted to vote on level of knowledge required doing both "worker" and "supervisor" at the same time. The facilitator would not agree to this process. I strongly believe we could have saved much time by not going over each task twice. Otherwise, other areas were good.
2. Tasks were not defined properly for their intended application.
3. Coffee would have been nice considering we paid for it yesterday.

GENERAL COMMENTS:

1. We were too rushed to get done and get back. The facilitator did not rush us, but knowing we were missing the larger group discussion caused me to want to rush.

GROUP: 3
TREATMENT: GDSS
DAY: 1
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Understanding was basically achieved quickly, making the task at hand much easier to accomplish.
2. We openly discussed disagreements and used our experience and logic in answering questions.
3. Good interchange of ideas.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Lack of two AFSCs was difficult and the answers where from the gut level.
2. We lacked an individual in Fuels.
3. Timing of class limited, probably hurt discussion some. We recognized this early and put Maintenance on the second day.

GENERAL COMMENTS:

1. I liked the software and use of computers.
2. Computer program shows other career field scores when all the way to the right—it can influence your decision.
3. The facilitator kept us focused and interacted when necessary to overcome conflicts.

GROUP: 3
TREATMENT: GDSS
DAY: 2
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. The group worked quite well today and yesterday.
2. We remained focused. We agreed easier on conflicts and communicated more freely.
3. Rare to get five people who can work together. We were very productive.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. We guessed somewhat on the Fuels functional area, but used logic and open discussion to resolve conflicts.
2. NOT!

GENERAL COMMENTS:

1. Good facilitating, and prompts by the technographer kept us focused. We also had less of a time constraint on second day, since first day was late afternoon after a long day of sitting in the larger group.
2. No change. Both days went very well. Good computer program. I think it enhanced our performance.

GROUP: 4
TREATMENT: FAC-MAN (non-GDSS)
DAY: 1
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Good crossfeed.
2. Each member was able to present their ideas and be honest with each other.
3. Learning experience. Good!
4. Good discussion of viewpoints.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Notes did not correspond to tasking.
2. Discussion lead by more aggressive members. Not everyone participated equally.

GENERAL COMMENTS: (None)

GROUP: 4
TREATMENT: FAC-MAN (non-GDSS)
DAY: 2
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. I feel each member added valuable input. Their ideas and thoughts were valid.
2. Everyone willing to entertain others perspective.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. I didn't feel there were any.
2. Understanding and definition of tasks appears to be a limiting factor on the overall success of this exercise.
3. It would have helped if sheets passed out on the first day that indicated the tasks, per meeting at Brooks, were in order. For instance, the group on "Weapon Systems Augmentation" contained numbers 50, 30, 49, 15, 18, 32, 26, and 48. If they were in order, our job would have been accomplished more efficiently and faster.

GENERAL COMMENTS:

1. Second day a better understanding of where people are coming from.
2. It was easier today, since we had been though the process twice.
3. I think things were more objective the first day, since everyone knew how to "play" the second day.
4. Ground rules were clearer. More aware of other people's nonverbal communication cues. More understanding of other's thought processes. Definitions of environmental tasks were already agreed to.

GROUP: 5
TREATMENT: FAC-MAN (NON-GDSS)
DAY: 1
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Good discussion of differing points of view and good points of explaining reasoning.
2. Very congenial group. Task oriented, good discussion (persuasive), and good listening.
3. Process worked well with solid participation by all.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Group had no members from two of the areas discussed (AAFES and DECA). Still some confusion over what tasks actually meant.
2. Unsure of full aspects or definition of some tasks. No representative in second career field category which forced group to make assumptions.
3. Not having reps from two of the agencies.

GENERAL COMMENTS:

1. Some task descriptions over-lapped or are vague.
2. This group was asked to rate four AFSCs, but there were not representatives for two AFSCs (AAFES and DECA). Not sure we were accurate in rating those areas.
3. Well facilitated. Willingness to work towards the good of the Air Force—focused!

GROUP: 5
TREATMENT: Manual
DAY: 2
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Same as provided on first session questionnaire. Learned more about process evaluation and about other areas involvement.
2. Very agreeable.
3. Well-organized and structured—team effort.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Really needed a better definition of what tasks involved, scope, and application intended to better assess task in relation to area (job).
2. Lack of knowledge with DECA career field. Some problems with task definition understandings.
3. Two agencies not represented.

GENERAL COMMENTS:

1. Used cards (1-5) first day—liked that better than voice voting. Helped in reaching consensus.
2. Yesterday's session had a facilitator and more energetic discussions, but also seemed more stressful. Learning curve involved in process and scoring decisions.
3. Preferred first day's process—a bit more time consuming, but drives more individual effort prior to team effort/concentration.

GROUP: 6
TREATMENT: Manual
DAY: 1
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. The group members worked together, listened to the viewpoints of others, and were flexible enough to modify their scoring when additional data surfaced.
2. Discussion was very productive. Everyone listened to other people's viewpoints and answers were based on true consensus.
3. Felt group was well-balanced in terms of personality, technical background/experience.
4. Consensus reached quickly.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Nothing really negative about the group or the process.
2. This group lacks working level expertise in the areas considered. Answers should be checked with these working areas.
3. Tasks were too vague in areas such as Emergency Response. Functional groups (i.e., plating shop) should be broken into three levels of responsibility (i.e., command, supervisor, worker).
4. Concerned that the definitions/interpretations used by the group for both jobs and tasks, while applied consistently within the context of the group activity, are different from those of other groups, and will make aggregation of results of questionable value.
5. Lack of understanding of issues.

GENERAL COMMENTS:

1. Issues need clarification to speed process up.

GROUP: 6
TREATMENT: FAC-MAN (non-GDSS)
DAY: 2
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. First vote with no discussion gave a real indication of how the member actually felt given his/her knowledge of the task and the career field.
2. All tasks are considered from a broad view given the variety of expertise in the group, giving, in my opinion, credibility to the process.
3. Consensus may have been reached with differing understanding in first vote. Quality of overall effort may have suffered.

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Initial votes led to the minority opinions (votes) being automatically defended by the minority voter. The member then stood their ground, to a certain degree, regardless of the discussion—this psychological outcome is probably based on a need to conceal a lack of knowledge about either the task or the target group. The method used today caused more conflicts to arise and the process was less conducive to a positive result.
2. The ability to talk through conflict and reach consensus was hampered by the structure of the voting process. There was a lower level of interaction among group members today. The formal voting system didn't work as well.
3. Too much pressure to compromise. Time crunch.

GENERAL COMMENTS:

1. I preferred discussing the task prior to voting as we did the first day. To vote first generates, as a rule, unusable data due to confusion of what the task really involves.
2. Use of number cards posed somewhat of a psychological barrier, in that it formalized our responses. Over time, this barrier was overcome somewhat (compensated for) as we became more comfortable with the mechanism.
3. More discussion of issues, because of not being aware of peoples starting position.

GROUP: 7
TREATMENT: Manual
DAY: 1
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Very organized and focused.
2. It was great!

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. None.
2. None.

GENERAL COMMENTS: (None.)

GROUP: 7
TREATMENT: Manual
DAY: 2
POSITIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE:

1. Good team—level/range of expertise was beneficial.
2. Professional, positive, and focused.
3. Excellent group!

NEGATIVE COMMENTS CONCERNING GROUP'S PROCESS OR EXPERIENCE: (None.)

GENERAL COMMENTS:

1. Group participation and problem-solving capacity was excellent!

Appendix P. Glossary

AAFES	Army Air Force Exchange Service
AF	Air Force
AFB	Air Force Base
AFIT	Air Force Institute of Technology
AL/HRG	Armstrong Laboratory/Human Resources Directorate/Logistics Research Division
DECA	Defense Commissary Agency
DP	Disaster Preparedness
DSC	Decision Support Center
DSS	Decision Support System
Exp	Experiment
FAC-MAN	Facilitated-Manual
GCSS	Group Communications Support System
GDSS	Group Decision Support System
GSS	Group Support System
HAZMAT	Hazardous Material
MIS	Management Information Systems
MTF	Medical Treatment Facility
NGT	Nominal Group Technique
PC	Personal Computer
TDY	Temporary Duty
USAF	United States Air Force
VIF	Variance Inflation Factor

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Vita

Captain Benjamin C. Huff was born in Abingdon, Virginia in 1959, and was raised in Chilhowie, Virginia. During high school he was inducted into the National Honor Society, and served as president of his senior class. Upon graduation in 1977, he was awarded the Air Force Academy's Falcon Foundation scholarship to attend Mallard Preparatory School in Bandon, Oregon. He later received an appointment to the United States Air Force Academy, Colorado Springs, Colorado, Class of 1982. Upon graduation in June 1982, then Second Lieutenant Huff was awarded the "First Lieutenant Dean A. Kinder" award.

Following Space Orientation and Orbital Analyst training at Lowry AFB, Colorado, then Lieutenant Huff was assigned to the 6595th Shuttle Test Group at Vandenberg AFB, California. He served as Chief, Space Shuttle Support Test Management Section where he was responsible for planning and directing real-time facility systems, logistics, maintenance, and communications support for launch pad ground operations involving Space Shuttle flight hardware processing. In June 1986, Captain Huff was assigned to the 13th Missile Warning Squadron, Clear AFB, Alaska. During this tour, Captain Huff was rated Highly Qualified in the Deputy Space Systems Director and Missile Warning Operations Crew Commander positions. He served as Chief, Standardization and Evaluation Section. Captain Huff was reassigned to Headquarters AFSPACECOM in July 1987 and served as the Command Manager for the AFSPACECOM Command Center and Air Force Space Operations Center. He was responsible for managing the acquisition of facility and C^2 communications, computer, and video systems in AFSPACECOM's first command post, battle staff, and support facilities.

Captain Huff completed a Master of Arts degree in Space Systems Management from Webster University, St. Louis, Missouri in 1992. His Space Operations curriculum at the Air Force Institute of Technology included special studies in the areas of Program Management, Decision Support Systems, Group Decision Support Systems, and Expert Systems.

Captain Huff is married to the former Lauren Vail Evans and has two children, Matthew Benjamin and Kristyn Elizabeth. Captain Huff was reassigned in January 1993 to the 45th Range Squadron, Patrick AFB, Florida as a Range Operations Director for US space launch operations.

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13. ABSTRACT (Maximum 200 words)

The research contributed to the study of Group Decision Support Systems (GDSS) in field experiments involving real managers making real decisions. This research was conducted by the Air Force Institute of Technology with the Air Force Armstrong Laboratory to evaluate the efficacy of using GDSS technology in an Air Force decision making environment. This study compared facilitated GDSS, facilitated manual, and unfacilitated manual decision making processes. This study focused on performance and secondary outcomes resulting from GDSS effects versus process structure effects. The research evaluated two performance outcomes: GDSS efficiency in terms of decision speed and effectiveness in terms of consensus. Post-process questionnaires were used to compare groups with respect to the participant's perceptions. The study concluded that GDSS, process structure, and group dynamics impacted performance. GDSS groups experienced lower decision speeds and consensus compared to facilitated manual groups which, in turn, experienced lower decision speeds and consensus compared to unfacilitated manual groups. Participants perceived the GDSS process as more difficult than the facilitated manual process. Likewise, participants perceived the facilitated manual process as more difficult, more structured, and producing more conflict than the unfacilitated manual process. These findings are consistent with other field studies which concluded that small groups or groups performing less complex choice-type tasks may not benefit from use of a GDSS.

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